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Xmas 2016
Issue 436

YOUR EXPERT



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GEAR REVEALED!

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WE SHOW YOU HOW TO GET
MORE SPEED FOR FREE —
EVEN IF YOU DON'T KNOW
YOUR MILLIVOLTS FROM
YOUR MEGAHERTZ



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BEEFY GAMING NOTEBOOKS

GET YOUR GAME ON THIS XMAS
WITH A PORTABLE GAMING PC
THAT WILL LEAVE YOUR
DESKTOP FOR DEAD!

TRUE GAMING LAPTOPS

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HOT TECH GEAR PUT TO THE TEST

- HP PAVILION WAVE DESKTOP PC: YES, IT'S ALSO A SPEAKER!
- NEW 13-INCH MACBOOK PRO: NOT ACTUALLY FOR THE PROs?
- SAMSUNG 960 PRO M.2 SSD: HOW DOES 3,300MB/s SOUND? + MORE INSIDE!

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- IPv6 & IPv4
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- Works with VigorACS SI management system

Vigor2860 Series



Vigor2860Ln

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- 4G LTE SIM card slot (L model)
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- 2 x USB ports support 3G/4G modem, file sharing or network printer
- Built-in object-oriented firewall
- IPv6 & IPv4
- 802.11n Wi-Fi (n model)
- Concurrent dual-band Wi-Fi (n-plus model)
- 802.11ac (ac model)
- VoIP (V model)
- Works with VigorACS SI management system

Broadband Multi-WAN VPN Firewall Routers



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Vigor2925Ln

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- Five Gigabit Ethernet LAN ports with 50,000 NAT sessions
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- IPv6 & IPv4
- 1 x USB port for 3G/4G modem, file sharing and network printer
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- VoIP (V model)



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Can using tech while driving ever be safe?

New figures from the US reinforce what everyone's been saying: using your phone while behind the wheel is deadly stupid. APC's editor weighs in.

A recent *New York Times* article (see tinyurl.com/apc436-drive) puts the blame squarely on distracting apps like Snapchat for a spike in US road deaths over the past two years. And while no similar study has (yet) been conducted in Australia, road fatalities do seem to have been on the rise over the last two years here, too. After a dip through 2013 and 2014, they've slowly been creeping up again through 2015 and 2016. At the time of print, the most-recent figures, for October 2016, showed that fatalities were 10.6% higher than average for the same month, calculated using data from the last five years.

Now, alcohol and fatigue are still undeniably the two biggest killers on our roads, but most Australian states recognise the danger smart devices present and, in the last couple of years, have passed laws specifically prohibiting use of phones unless they're secured in a cradle/holder. And it often goes a bit further than that.

Victoria and NSW, for example, both have wording that state that the only legal actions you can perform on your phone are voice calls, music playback and navigation. And the former two uses require hands-free interaction, with the Victorian laws stating that the condition of use is that your phone "can be operated by the driver without touching any part of the phone, and the phone is not resting on any part of the driver's body."

Our digital devices demand our attention in a very exclusive way.

A lot of the problem is biological – so don't feel personally affronted by this fact. While humans are excellent at zooming in and paying attention to a single task or object, we're not actually very good at monitoring multiple things at the same time – the ubiquitous 'invisible gorilla' video (see www.theinvisiblegorilla.com) should pretty clearly demonstrate to anyone who's tried it that, well, we kind of suck at dividing our focus. Anything that takes your attention off the road is, therefore, a potential hazard.

In practical terms, then, the best advice is the same as it's always been – it's best not use your device at all, and if you must use your phone, do so sparingly and with specific hands-free, car-optimised apps. Resist the temptation to read and reply to text messages – even if you're dictating replies via a digital assistant (like Siri or Google Assistant), that's still stealing enough of your focus to be dangerous.

And even if your eyes are taken away from the road for just a few seconds, that's all it takes for the worst to happen. So be smart: don't use your smartphone when you're behind the wheel. ■



DAN GARDINER
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"We have a psychopathic former reality-TV host as the leader of the most powerful nation in the West. The trolls have verily won." End User, p19



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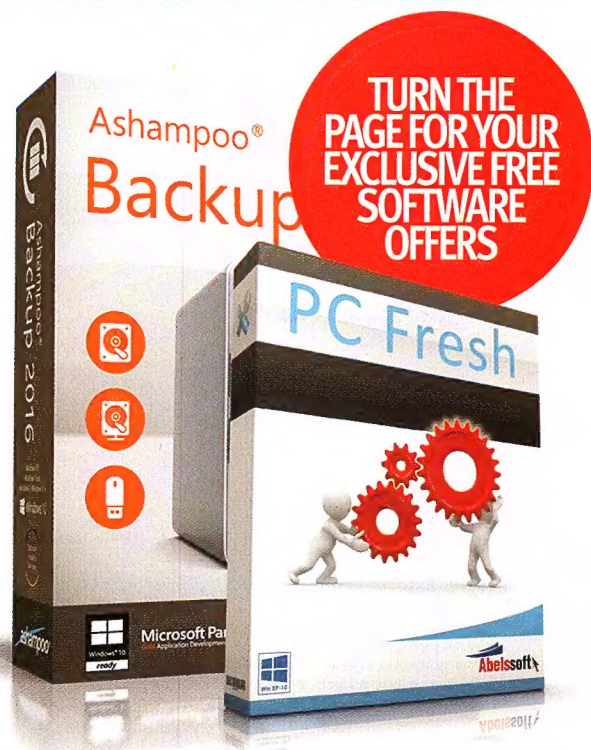
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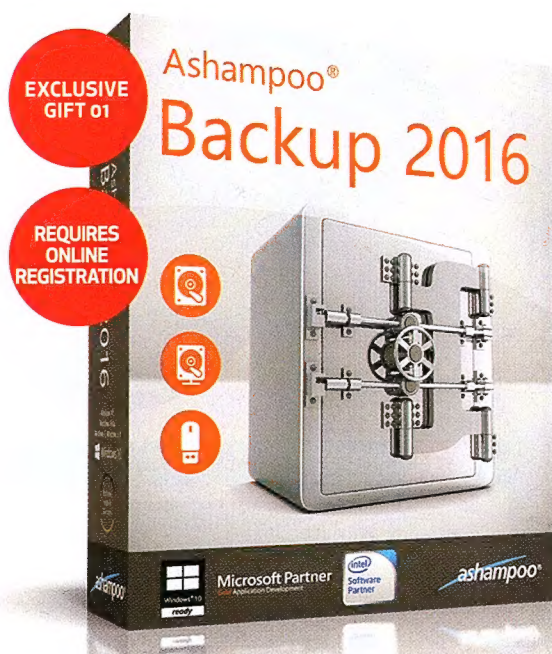


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ISSUE 436, CHRISTMAS 2016

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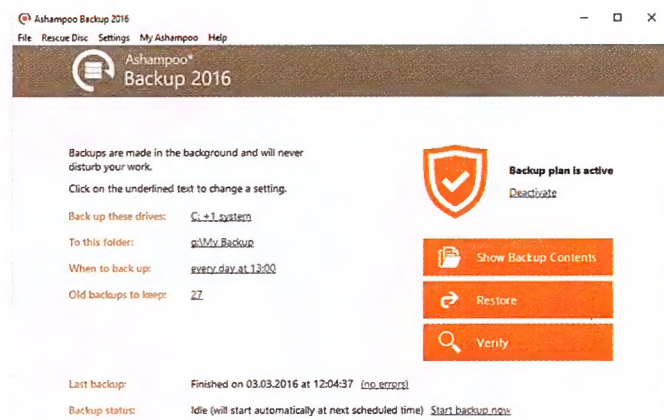
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Secure your data with Ashampoo Backup 2016.

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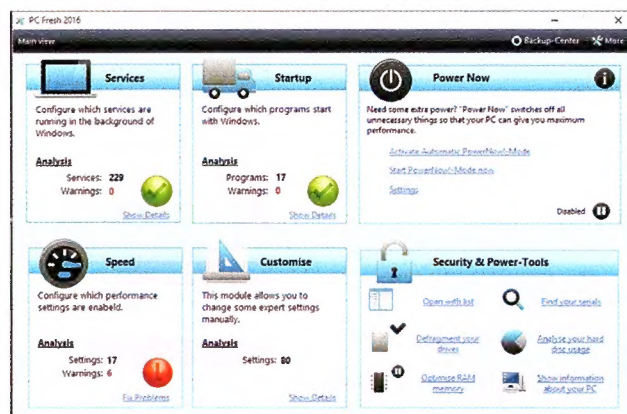
MAKE SURE YOUR PC WORKS FOR YOU

Cleanse your PC of gunk with Abelssoft PC Fresh.

FULL VERSION WORTH \$30.

Windows does what it pleases — and that's usually far too much. PC Fresh 2016 cuts the fat off, ending unnecessary Windows services, pruning startup programs and resolving system slowdowns. Additionally, the software finds lost application serial numbers hidden on the system and allows the user to customise various aspects of Windows. The new 2016 version of PC Fresh includes, for the first time, a manager for easily assigning file associations (for example, opening TXT files with WordPad).

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technotes

» NEED TO KNOW



Cutting the PC's VR cord

HTC VIVE GOES WIRELESS VIA US\$220 UPGRADE KIT.

Being shackled to your PC via VR headset cabling could soon be a thing of the past. Headset maker HTC has partnered with TPCAST to develop a wireless upgrade add-on — currently being marketed as a 'preview edition', and it promises Vive users a wireless virtual reality experience. The battery-powered add-on is available for pre-order, but neither HTC nor TPCAST have clarified how it works. **SS**

After Trump victory, Facebook promises to crack down on fake news

ZUCKERBERG SOUNDS OFF ON ACCOUNTABILITY.

The recent American presidential election has been historic, to say the least. After accusations were cast that Facebook played an influential role in determining the outcome of the elections, the social media's chief executive took to Facebook to defend his company. In a post on his personal page, Mark Zuckerberg said more than 99% of the news shared on the site was authentic and only a small percentage was false or a hoax... the kind of news incapable of influencing politics. He did, however, acknowledged that Facebook had plenty of work to do in weeding out fake news. "I am confident we can find ways for our community to tell us what content is most meaningful," his post read, "but I believe we must be extremely cautious about becoming arbiters of truth ourselves." He went on to say, "We don't want any hoaxes on Facebook. Our goal is to show people the content they will find most meaningful, and people want accurate news." **SS**



Is your smartphone spying on you for China?

From Beijing with love.

Security firm Kryptowire has exposed a pre-installed backdoor in the firmware of some budget Android phones. The backdoor reportedly sends its user's data to servers in China every 72 hours. According to American authorities, it's unknown whether the collected information is being used for advertiser data-mining, or as part of a nefarious intelligence collection scheme by the Chinese Government.

Shanghai Adups Technology Company, who wrote the software, says it has been installed on over 700 million devices. American phone manufacturer BLU Products says that 120,000 of its phones were affected and have since been updated to remove the backdoor. On its website, Adups lists several Chinese multinational phone manufacturers as its clients, including ZTE and Huawei.

When reached for comment, the latter stated: "Huawei takes our customers' privacy and security very seriously, and we work diligently to safeguard that privacy and security. The company mentioned in this report is not on our list of approved suppliers, and we have never conducted any form of business with them." **Stephen Lambrechts**

Elon Musk aiming to launch global satellite-based internet service

IS THERE ANYTHING HE CAN'T DO?

Elon Musk's aerospace corporation SpaceX has plans to launch low-orbit satellites that will reportedly bring low-latency internet at gigabit speeds to the entire world. The company's plan was revealed in an application filed to the US Federal Communications Commission asking for satellite space station authorisations. SpaceX wants to launch 4,425 satellites at altitudes ranging from 1,150km to 1,324km. **Stephen Lambrechts**



Watch what you tweet SOCIAL MEDIA MONITORING COULD BE USED TO ADJUST YOUR PREMIUMS.

Insurers are monitoring the insightful data generated by social media to tailor policy pricing. So tweeting about or 'liking' extreme sports could lead to an increase in your insurance premium, whereas being a fitness fanatic could be a good thing for your pocket. But critics are worried about the loss of privacy and the increase in differentiated pricing. **SS**

Revenge porn reporting tool funded by AU Govt NOW A JAILABLE OFFENCE.

With the increasing number of incidents of revenge porn — the non-consensual sharing of sexually-explicit images — being reported, the Australian Government recently announced it's developing an online tool to report cases and to provide support to victims. Expected to be launched in 2017, the tool will be managed by the Office of the Children's eSafety Commissioner, with \$4.8m set aside for the project. **SS**

Next Wi-Fi standard devices arrive AND THEY'RE WI-FI ALLIANCE CERTIFIED.

The non-profit association formed to promote Wi-Fi tech has launched its WiGig certification program to help further the spread of 802.11ad specification and low-latency, multi-gigabit wireless broadband. Among the devices certified are Intel's Tri-Band Wireless 18260 and Qualcomm's QCA9500 chipsets. The Wi-Fi Alliance will continue certifying products, with the expectation that volumes of WiGig products shipped in 2017 will increase. **SS**

Drones dissing gridlocked drivers ULTIMATE ADVERTISING?

Earlier this year, drivers stuck in traffic in Mexico were "heckled" and "badgered" with ads for Uber's carpooling service, with banners carried by drones hovering over traffic jams. Reprimanding the locals for not carpooling or using public transport, the ads read, "The city for you, not 5.5 million cars," and, "Driving by yourself? This is why you can never see the volcanoes." **SS**



Amazon finally launching Down Under in 2017

But will it spell doom for local retailers?

As reported by the *Australian Financial Review*, Amazon will finally arrive on Australian shores next year, and according to Justin Braitling, chief investment officer at Watermark Funds Management, the online retail behemoth's arrival could spell trouble for local retailers' profit margins.

Braitling, who recently received a special briefing on Amazon's Australian strategy, says that the US retail giant has deferred its Aussie launch until September 2017 in order to include fresh goods amongst its online offerings. "They will be dropping distribution centres and performance centres in every state next year," said Braitling, further stating that Amazon "will be doing general merchandise and they will be doing fresh as well".

Braitling also divulged Amazon's plans to open stores on the ground in regional parts of Australia, expressing concern for how damaging the US company will be to our local businesses. "We spoke to the guy rolling out Amazon's business here in Australia and in his words: 'We are going to destroy the retail environment in Australia.'" **Stephen Lambrechts**

'Script kiddies' likely behind October's massive DDoS internet outage

IT ALL POINTS TO AMATEURS, ACCORDING TO REPORT.

Though many believed that state-sponsored actors with ties to Russia were responsible for the enormous DDoS attack that caused internet outages across the US in October, an analysis from business risk intelligence firm Flashpoint has placed the blame on amateur hackers. "While there does not appear to have been any disruption of service, the targeting of a video game company is less indicative of hacktivists, state-actors, or social justice communities, and aligns more with the hackers that frequent online hacking forums," stated the analysis, written by Flashpoint's Allison Nixon, John Costello and Zach Wikholm. "These hackers exist in their own tier, sometimes called 'script kiddies', and are separate and distinct from hacktivists, organized crime, state-actors, and terrorist groups," the analysis explained. "They can be motivated by financial gain, but just as often will execute attacks such as these to show off, or to cause disruption and chaos for sport," they said, suggesting the hackers want to "troll" and "gain attention by causing disruption to popular services". **Stephen Lambrechts**

technotes

» CARMEL SEALEY LOOKS AT THE NUMBERS DRIVING THE BIG TECH NEWS.



THE PRICE FOR SNAPCHAT'S PLANNED VIDEO-CAPTURING EYEWEAR

Despite the fact that the Google Glass was widely criticised, and mocked, back in 2014 (for both privacy and plain fashion reasons), Snapchat seems to think the idea is still worth pursuing. The message service recently announced that its Spectacles would soon be available and would cost about US\$130 (AU\$170). The sunglasses come with "an integrated video camera that makes it easy to create Memories", Team Snap posted. Capturing video from the perspective of the wearer, this camera would show a 115-degree field of view and connect via Bluetooth and Wi-Fi. However, they're hardly a unisex design...



4 million

THE NUMBER OF AUSTRALIANS SOON TO GET APPLE PAY

More than 30 credit unions and smaller banks have recently announced that their customers will have access to Apple Pay — a contactless payment method which can be used with an iPhone or Apple Watch — including Credit Union Australia, Bank of Sydney, Bank Australia, Teachers Mutual Bank Limited, Woolworths Employees' Credit Union and People's Choice Credit Union. This will give over 4 million customers in Australia the ability to use the service, while the largest banks in the country are still dragging their feet.



US\$8,000

THE PRICE CHINESE CUSTOMERS COULD PAY FOR AN ELECTRIC VEHICLE

While at the tech conference Web Summit 2016 in Lisbon, the CEO of the Renault-Nissan Alliance, Carlos Ghosn, said the progression of electric vehicle adoption around the world was slow "but at some point, it will accelerate". One of the barriers preventing potential customers from dipping their toes into the market in China, for instance, is the price of the vehicle compared with regular cars. The Alliance has, therefore, begun to develop a vehicle which it hopes will cost no more than US\$8,000 and will require no government subsidies to entice buyers.



20%

VACUUMS THAT ARE NOW ROBOTS

According to the CEO of iRobot, Colin Angle, 20% of the world's vacuum cleaner market is now made up of robots. Speaking at TechCrunch Beijing 2016, a conference and hackathon event, Angle revealed that over 14 million devices — a staggering 70% of that robot workforce — were Roomba machines, the floor-roaming giant ice hockey puck-style vacuum cleaners that have either terrorised household pets or provided them transport around the home for years. With such a dominance in the market, it would take a fairly revolutionary device to shake the tree.

20,000

THE NUMBER OF TESCO BANK ACCOUNTS HACKED

Early in November, customers of UK financial institute Tesco Bank were locked out from making online transactions after it had been discovered that money had been stolen from 20,000 accounts (with an additional 20,000 reporting suspicious activity). The UK's National Crime Agency is leading the investigation into the hack, a "systematic, sophisticated attack" which saw an estimated one in seven Tesco Bank accounts affected. The bank has not, at time of writing, stated when the debit cards will become operational again; however, they have said they would refund any unauthorised transactions as soon as they could.





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» CARMEL SEALEY WADES INTO A CURRENT NEWS TOPIC TO TAKE A CLOSER LOOK



CSIRO, AI and zombies

THE NIGHTMARE MACHINE COMES TO TOWN

The CSIRO and the Massachusetts Institute of Technology has created an algorithm-based piece of AI that transforms images of people into hellish zombies. The images were put into an online survey and participants were asked to rate how scary each was to them. The results were then fed back into the algorithm, which learnt how to make scarier images. The aim of the Nightmare Machine is actually to discover how to provoke *positive* emotions in people; but the machine must first learn what scares people, so that it doesn't use those kind of images.

Does this unit have a soul?

ITALIAN SCIENTISTS AIM TO MAKE A ROBOT WITH A CHILD-LIKE MIND CAPABLE OF LEARNING

The human mind is so complex that scientists are far from understanding how it works, and yet, Italian scientists are attempting to emulate its ability to learn by developing a robot with the same kind of 'blank canvas' brain as a child. The process of the experiment from Goal Robots is to place the robot in an environment where it can learn from activities (as a toddler would learn from playing with blocks) and then "apply their new acquired skills" in an independent fashion.

The future of the human worker

ELON MUSK EXPECTS A UNIVERSAL INCOME FOR HUMANS REPLACED BY ROBOTS

So what happens when the human race achieves a level of artificial intelligence and integrated robotics that we increasingly become obsolete in terms of a cost-effective workforce? How could the common man afford to live without a salary? The founder of SpaceX and Tesla, as usual, has come up with a potential solution. "I think there's a pretty good chance we end up with a universal basic income, or something like that, due to automation," Elon Musk (our saviour) said. ■

Keeping an eye on AI

"Is this the human quality you call friendship?"

When most people think of artificial intelligence, the first image that probably comes to mind will be of Arnold Schwarzenegger from the *Terminator* franchise, the machines and Agent Smith from *The Matrix*, Sonny from *iRobot*, HAL from *2001* or the many other AI and robot characters from equally post-apocalyptic or dystopian stories (unless, of course, you're a fan of *Red Dwarf*, because Kryten is a dear). However, despite our fears, those sorts of realities are thankfully still some distance away, and possibly the realm of the imagination – the AI of today is more centred on helping humanity than trying to destroy it. From chatbots to virtual assistants, robot football players to driverless cars, the way AI technology seems to be going (for the meantime, anyway) is aiding us in our day-to-day lives, in both small- and large-scale ways. So what have AI and robotics been doing recently?

StarCraft training artificial intelligence

"AH, ANOTHER SOUL IN SEARCH OF ANSWERS..."

As we reported on page 114 in APC 434, artificial intelligence systems benefit from playing computer games, and just as Telsa software has been playing *GTA*, it's now time for other researchers to whip out the mouse and keyboard and sit their own AI down to play some real-time strategy in the form of *StarCraft II*. The Google DeepMind team, which is responsible for developing the tools for the researchers, said that *StarCraft* "provides a useful bridge to the messiness of the real world", involving multiple layers of decisions and prioritising... and killing aliens (or humans).

Woof, woof!

MIRO — THE PERFECT COMPANION FOR THE ELDERLY

MiRo is a robotic dog that is programmed to detect "a break in routine", designer Sebastian Conran explains. But like a true companion, it will also remind you to take medicine, use face recognition technology to help you identify visitors and also enquire about your health. If there is a problem, MiRo will have the ability to contact a carer "who can see your heart rate and body temperature, and rewind your life using the cameras in the home to see what happened". According to Conran, the end goal is to include a robotic arm that can help with more physical tasks — though we hesitate to imagine what an arm coming out of a cute plastic puppy would look like...

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» GEAR WE WANT

CAT S60 GSM SMARTPHONE

A hot new smartphone that'll take a beating.
WWW.CATPHONES.COM | US\$600

Mining and construction-machinery manufacturer CAT has its sights set on the technology sector, with a new smartphone that is as rugged and hi-tech as an Ironman suit. Not only is this carbon-fiber and dye-cast steel framed smartphone impervious to being dropped onto concrete from 1.8m, it's also certified to swim at a depth of up to 5m. The 4.7-inch handset has a Gorilla Glass-clad touchscreen and features a midrange Qualcomm Snapdragon 617 CPU, 32GB of internal storage, 3GB of RAM and a 3,800mAh battery. Its rear 13 megapixel camera also features a thermal imaging sensor, a handy tool to have in a Swiss-Army phone.



JIDE REMIX IO+

The smartest 4K media player is almost on the market.
WWW.JIDE.COM | -US\$129; US\$99 FOR REMIX MINI OWNERS



Last year, Chinese startup Jide released its first Android-based mini-PC, the Remix Mini, through Kickstarter, raising over US\$1.6 million from close to 22,000 backers around the world. This year, the company – founded by three ex-Google employees – is looking to dominate 4K in the living room with another Kickstarter and an upgraded product: the Remix IO+. Coming in at US\$129, this media player cum mini-PC packs a six-core ARM RK3399 2GHz CPU, Mali T864 GPU, 4GB RAM, 32GB onboard storage and can output 4K visuals at 60fps with 10-bit HDR colour through a comprehensive selection of connection options. This little Android 7.0 (aka Nougat)-based PC, of course, features the popular Remix OS, but also adds a 10ft-interface for use with the included remote.

SONY PLAYSTATION 4 PRO

The mid-generation 4K update for your living room.
WWW.PLAYSTATION.COM/EN-AU | FROM \$349

If you've picked up a 4K TV in the past couple of years then you've probably noticed that both Microsoft and Sony have recently introduced mid-generation updates to their respective Xbox and PlayStation consoles which are capable of upscaling games to 4K and outputting deeper colours on HDR compatible screens. The PS4 Pro technically does more than just upscaling, though, adding a new AMD GPU with more than double the processing capacity of the regular PS4, while also increasing the storage to 1TB and updating the USB ports, Bluetooth and Wi-Fi to the latest standards. If you don't have a 4K TV, you'll see a framerate increase on a selection of games. However, unlike the Xbox One S, the PS4 Pro can't play UHD Blu-ray discs.





CINEBODY S6

Turn your iPhone into a camera, a proper one.
CINEBODY.COM | US\$199

This is one for retro video lovers. Insert your iPhone 6 or 6s (unfortunately for Android and Windows phone users, this handy little gadget is for Apple-lovers only) into the Cinebody case, open the accompanying app – Cinebody – and connect the cable to enable the microphone and trigger at the front. Now you've got an ergonomic way to shoot video on your iPhone! You can use the eyepiece to line up your shots, record great-quality audio using the microphone, and you just press the trigger to start shooting. There's also a cold shoe mount for adding lights or handles, and you can buy lenses (a 0.45x macro and 2x telephoto) for just US\$30, giving you extra shooting options. The product appears to be super popular, too, with many elements selling out fast. So jump on it if this is your jam!

GOPRO HERO5 BLACK

Two years in the making and totally worth it.
\$550 | GOPRO.COM

If you like extreme sports but prefer not to risk your \$1,000 flagship mobile phone, look at GoPro's latest 4K action cameras. In the new Hero5 range, the Black and Session can shoot 4K at 30fps, and the former also has a touchscreen, GPS and can shoot raw photos. They're waterproof, dust-proof and produce really excellent-quality video. Highly recommended for any outdoor activities.



AUDEZE iSINE 10

In-ear plugs from the sound behemoth Audeze.
AUDEZE.COM | \$599



Audeze's iSINE 10s are the world's first in-ears to use planar-magnetic drivers – usually found in larger, over-ear headphones. They use of planar technology instead of conventional balanced-armature or dynamic drivers ensures more precise control and faster response times without distortion. They also contain Audeze's patented Fluxor magnets and Uniforce voice coils to deliver accurate, high-end sound quality. They weigh 20g and come with earhooks to keep them in place. The iSINE 10s ship with a Cipher Lightning cable, which is fitted with a high-quality inline amplifier, DAC and DSP. That means you can enjoy 24-bit hi-res audio (another world first) with the iSINE 10s handling the signals instead of your device. You can even customise the sound in real time with the iOS app (sadly, no love for Android users), which boasts a ten-band equaliser, as well as two presets that'll remember how you like to hear your music. ■

technotes

» HOW IT'S DONE

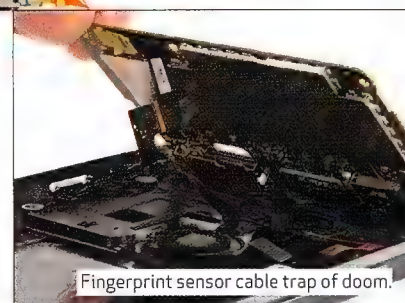
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Google Pixel XL

Relatively simple — eerily similar to Apple.



Today marks our first ever teardown of a phone designed entirely by Google: the Pixel XL. What to expect? At first glance, it bears more than a passing resemblance to an iPhone — but it's the innards in which we're interested, of course...

MAJOR TECH SPECS

- 5.5-inch AMOLED display, with QHD 1,440 x 2,560 resolution (534ppi) and 2.5D Gorilla Glass 4
- Quad-core, 64-bit Qualcomm Snapdragon 821 processor (2.15GHz + 1.6GHz), with 4GB LPDDR4 RAM
- 12.3-megapixel, f/2.0 main camera, with phase detection autofocus, and laser detection autofocus; 8MP selfie camera
- 32GB or 128GB built-in storage
- Pixel Imprint back-mounted fingerprint sensor
- USB Type-C port and 3.5mm headphone port
- Android 7.1 Nougat

KEY FINDINGS

- Given the familiarity of this iPhone lookalike, our confidence nears

cockiness as we take a play from our iPhone 7 Plus guides, heat an iOpener and select our lucky opening pick. After a minute of heat and a minute of prying, we lift open the phone from the top, expecting to expose its inner workings. But a screwed-down bracket on the display cable halts our progress. Time to dust off our driver, and dive a little deeper.

- The slim and rigid midframe is likely made of magnesium, and is clipped on to the body of the phone. When we say 'rigid', we expect it to not be 'bendy'. We expected wrong. Oops! On the left, the midframe holds a mysterious ribbon connector and an earpiece speaker. And to the right, the rest of the phone, complete with motherboard in matte black.
- Two strips of strong adhesive secure this HTC-made battery, but the pull tab does its job without heat. This 13.28Wh battery beats the 11.1Wh iPhone 7 Plus, but not the Galaxy S7 Edge, with its 13.86Wh powerhouse. Worthy of note: The Galaxy Note 7 packed a 13.48Wh battery before its demise.

- We really wanted to look at this motherboard, but were thwarted by a fingerprint sensor cable boobie trap! Fortunately, it's easy to disarm. Next is another mini board with mic, and the rangefinder that enables laser autofocus.
- **Repairability Score:** 6 out of 10 (10 is easiest to repair). Many components are modular, and can easily be replaced once the display assembly is removed. The battery has a removal tab, and is adhered by a modest amount of adhesive, making removal painless. All the screws are T5 Torx. The opening procedure requires prying up a thin, poorly-supported display assembly, making it difficult to open the phone without damage. In addition to screws, the midframe is secured by snug, press-fit notches, which make its removal (and subsequent repairs) laborious. ■

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» EPINIONS



Are Netgear's routers really best when it comes to parental controls? It depends on what your specific needs are...

REAL ROUTER PARENTAL CONTROLS

APC's superguide on networking in issue 427 (April 2016) recommended Netgear routers for their superior parental controls. Based that that recommendation I purchased the Netgear Nighthawk X6 R8000, however, the parental controls were a real let down and completely unusable in our situation.

I want to be able to set a schedule in advance that automatically regulates their access to the internet. I want that schedule to allow definition down to 15 minute time blocks and I want the schedule to be able to be set up differently for weekdays and weekends. I want the scheduling to be assignable to a group of devices (my son has a Phone, tablet, computer and PS4 – and all need the same schedule). I want to be able to override the schedule and toggle on total blocking (as a disciplinary option). And when I toggle off that total block, I want the previous schedule to resume. No-one's routers do this...

[Ed's note: long list of specific configuration problems snipped for space.]

Ultimately, I took the Netgear router back for a Linksys EA8500. Linksys'

software is also not ideal. But at least I can get the Linksys controls to work, which is more than can be said for Netgear's.

I wanted to relay my feedback so that APC doesn't laud Netgear routers for their parental controls in future.

Thanks for a great magazine and keep up the good work.

Stuart Iggo

APC's networking expert **Nathan Taylor** replies: That's not entirely unfair; Netgear's solution is far from ideal. However, I do think it's better than anyone else's, at least when it comes to commercial firmware. I've noted several times that it just uses OpenDNS, which is actually available to everyone, but said it was nice that it was built into the Netgear routers and that there was an app available to set rules and bypasses for individual users, something not normally available with OpenDNS. The app not being available for Windows RT (I presume the Surface tablets are not running regular Windows, or they could just use the Windows app) or the other exotic platforms is a problem, but it's probably

to be expected. On those platforms you can just use a third-party DNS (such as Google DNS at 8.8.8.8) in any case, which bypasses the OpenDNS parental controls completely.

If you want the kind of granularity and live control you're talking about, I'd recommend a software-based solution like Norton Family which has agents that can be installed in Windows, Android and iOS. You only have to install it on the devices that need it. There is a deprecated free version, but for the kind of things you want, I'd recommend the paid version.

If you're feeling a little more adventurous (and really want the control built into the router), then some third-party firmwares like DD-WRT and OpenWRT have sophisticated options, but they're not for the faint of heart. They can use OpenDNS combined with MAC-based identification of devices to set access times for individuals, while parents' devices will have to use the DNS trick noted above to bypass OpenDNS. You still won't have a manual override switch or some of the things you're looking for, but it may be closer to what you're after. ■

APCMAG@FUTURENET.COM

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Trump, Facebook and the rise of the post-truth era

They said the internet would bring us all closer together, but has it actually pushed us further apart? Shaun Prescott investigates.

American News, otherwise known as 'The Patriot Review', is a Facebook page with nearly 5.5 million followers. With its heavily conservative bent, it shares stories with headlines such as 'Michelle Obama Picks A Fight With Melania Trump, Learns Instantly That Was A Huge Mistake' and 'Innocent Father To 4 Dies Because Of Reckless Anti-Trump Protesters Blocking The Road'. These stories are sensational in the good ol' British tabloid tradition, but they're also, largely, patently untrue.

Pages like these are starting to present a problem for Facebook. Since the unexpected victory of Donald Trump in the US election last month, critics have warned that the company should take responsibility for the false news that proliferates on the platform. While the company denies that it could possibly have influenced the outcome of the election, it doesn't take much scratching around to find huge nests of deliberately falsified viral news (or if we're going to be honest, propaganda), with astonishingly huge audiences.

Zuckerberg hasn't taken the responsibility on just yet, though 'fake news' has joined 'illegal content' as material that Facebook's advertising will no longer appear on. In terms of banishing this kind of material altogether, he pointed to stats showing that the number of offending pages are low (because of course they are — compared to the millions of total Facebook pages).

Meanwhile, the algorithm Facebook uses to determine what its users see, while still mostly shrouded in secrecy,



is based on engagement. In other words, if a story is very popular among the people you're friends with, you're more likely to see it. In this way, users are increasingly subjected to an echo chamber of competing sites, all vying for your attention in the most heavy-handed ways possible — and more often than not, they'll pander to your pre-existing views. That's an especially toxic combination when that algorithm is inadvertently determining the sentiments of American voters — especially those liable to swing.

According to a BuzzFeed report, some Facebook employees are upset about the proliferation of 'fake news' and are trying to deal with it in an internal "renegade" taskforce. Meanwhile, Google has announced it will ban "fake" news sites from receiving ad revenue from its advertising services. Another BuzzFeed analysis claims that "fake news" had more virality during the campaign period than any traditional



(i.e. legitimate) news source. If these sites really are as influential as they appear to be, then the damage has already been done: we have a psychopathic former reality-TV host as the leader of the most powerful nation in the West. The trolls have verily won.

And Trump is one of them: independent fact-checking sites such as PolitiFact and FactCheck.org have confirmed he told hundreds of lies and half-truths during the election campaign, which, when combined with his seeming obliviousness to any of the finer-details of running a country, is likely to be a volatile mix. Trump knows that gestures and pandering and, importantly, appealing to those disenchanted with "the establishment" (which the New York billionaire claims to not belong to) are more important than anything as trifling as detail. It's fitting that Oxford Dictionaries has declared that 'post-truth' is the 2016 international word of the year. ■

END USER

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LAPTOP

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Apple MacBook Pro 13-inch (Core i5, Late-2016)

Is this a new low-end Pro, or a new high-end Air?

Apple's newest MacBook Pro isn't equipped with the new Touch Bar control strip. Compared to the two models with Touch Bar, it has fewer ports and a lower processor speed at 2GHz. Apple emphasizes that this new MacBook Pro is actually thinner than the MacBook Air at the Air's thickest point, has a smaller overall footprint, and is essentially the same weight. Based on a quick glance, you almost feel like it would make more sense if Apple had made this a new 13-inch version of the MacBook, with the Pro name reserved for models with the Touch Bar – it would have made for a clearer line-up.

As we started to test it, we could see why Apple was happy with the Pro name. Its dual-core Intel Core i5 processor seems like it could be lightweight, but it actually proved to be almost

as powerful as the 2.7GHz processor in the previous-generation entry-level model. That machine managed our real-world video encoding test in 57 minutes, while this machine took 55. This amount of processing power makes it more than capable of mid-range video editing and photo work, impressive to fit in a smaller, lighter frame with the same battery life.

Even more impressive is the big step forward in graphics power of the new chip. Intel's Iris 540 GPU is a much more advanced design, and this can produce some big results. In our *Batman: Arkham City* test, we got an improvement in frame rate of more than 50% over the previous model. This is great for other intensive apps, such as Photoshop or Final Cut Pro, which can use GPU power to speed up certain tasks. It's still no gaming powerhouse, but it's a big improvement.

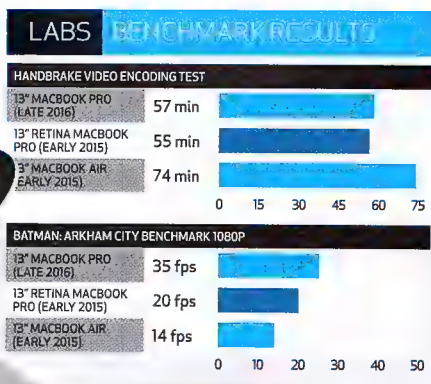
Another improvement is the storage, which is now so fast, it's ridiculous. In BlackMagic's Disk Speed Test, we recorded a speed of 1,241MB/s for writing to the MacBook Pro's internal SSD. We switched to Xbench to get accurate drive read speeds, recording around 3,000MB/s at the peak. It's an astonishingly fast set of storage – perfect for those working with giant media libraries, including video editing and photography.

The machine comes with 8GB of RAM, which should be fine for most people. You can upgrade to 16GB when you buy, and you can also get more than the default 256GB of storage, or upgrade the processor to a 2.4GHz Intel Core i7 model – but the \$480 price for the latter is the almost the same cost as upgrading to the 2.9GHz Touch Bar model.

The display is still a 2,560 x 1,600-pixel Retina display, but is now much brighter

and features the wide colour gamut seen on the Retina iMacs, iPad Pros and iPhone 7. This is nice for pros working on cinema-quality video or high-end photographers, though perhaps they won't be using this particular machine for that work. However, it does let anyone view the wide colour photos that the iPhone 7 takes in their full glory. The brightness is often more subtle, since a lot of time you'll likely have it down around the half-brightness level just in standard home lighting. But if you're in a much brighter place at risk of reflection, it can help a lot. Overall, it's just a really detailed, vivid, stunning screen.

The keyboard is now the new style that premiered with the 12-inch MacBook, though in an updated form, with switches that have a marginally 'clickier' feel, offering more feedback. We know the new keyboard



is a divisive topic: we really liked it on the MacBook, and this version is slightly improved. We love the crisp feel with the large size of keycap, and find it perfectly accurate and comfortable. But we know the lack of travel (and accompanying sharp feedback) isn't to everyone's taste. If you didn't like it before, we doubt anything will have changed.

The trackpad has had a size increase too, though we found this also to be a subtle improvement. More space for dragging your finger around is nice, and the bigger size didn't interfere with our typing, but it's not a revelation.

LOUD AND QUIET

Apple has also included new speakers, which are a vast improvement. They deliver a fuller sound across the range, with especially improved bass helping to make everything feel

less tinny. They also go a bit louder than on the old model. Ironically, in other ways, Apple has made the machine impressively quiet – we only noticed the fans make significant noise when running our *Tomb Raider* graphics test. Just browsing the internet was silent.

Battery life is fantastic. Apple still rates for around 10 hours of usage, so it can last a whole work day, but that depends on what your work entails. We used the machine on and off power without ever pushing it down past 65%. For writing this review, we unplugged, wrote in Pages for over an hour with the display at half brightness, and used just 5% of the battery.

That said, we can't talk about usability without discussing the ports. Two Thunderbolt 3 ports don't go very far when one of them is also your power connection. Adapters for basic USB and SD card readers are

inexpensive, but you'll definitely need to invest in one. For those coming at this machine as a MacBook Air replacement, this will probably seem okay. As a replacement for an entry-level MacBook Pro, it's a major drop in native connectivity. How much of a problem this is will depend on your setup. If you have quite the command centre of connected accessories, you'll want to look to either the Touch Bar model (which has four ports), or getting a powered hub, costing about the same as upgrading.

That idea of approaching this as an Air vs a Pro holds true in a lot of aspects when it comes to judging this machine. As an Air replacement, it's wonderful – more powerful, more usable, with a Retina display – though it's also massively more expensive compared to the 13-inch Air. As a new entry-level Pro, it's a really nice machine for those who

work on the go, but you'd need to value the extra portability and better screen a lot to buy it over the previous model still on sale, while also not being willing to spend the extra \$500 to upgrade to the superior Touch Bar version.

So in conclusion, we really like this machine – it's fast, usable, with a lovely screen. But it's sitting in a slightly awkward middle ground in Apple's line-up – and one of the many other models may ultimately suit you better.

Matt Bolton

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Apple's new entry-level Pro offers some interesting features and great battery life, but it's awkwardly positioned.





DESKTOP COMPUTER

\$1,299 | WWW.HP.COM/AU

HP Pavilion Wave Desktop (600-A051A)

Leading the way in a new wave of computing.

Apple's latest Mac Pro is often ogled and not just because of its high-end components, but because the cylindrical nuclear-reactor-shaped PC is an amazing piece of technical engineering.

Unfortunately, the high price of the Mac Pro has meant that, for most people, it's just been something to look at, rather than something you could justify actually buying. HP's new desktop PC is hoping to quench some of that burning desire for a fancy-looking desktop PC that doesn't cost as much as your average premium gaming desktop. Thanks to HP's partnership with the design savvy high-end audio brand Bang & Olufsen, this fabric-clad mini tower PC wouldn't look out of place alongside a desk full of architectural scale models or as the centrepiece of a stylish open-plan living room/office. But its looks

aren't the only thing that's impressive about the Pavilion Wave – it can also play games... at least a little.

Since the majority of people who saw the Wave without any context believed it to be a speaker, let's explore the sound first. It's natural to have high expectations when you consider that B&O are behind the audio, but we'd have to advise restraint since most speakers from B&O fetch a higher price than this mini-PC in its entirety. The sound emanates from the top of the unit in a 360° vent that makes it exceptionally good at delivering even sound to a whole room if it's in the centre. Yet this unique ability for playing multidirectional music has some notable limitations when it comes to media playback and gaming, since you lose the directional perception that you get from two speakers.

The Wave also houses an assortment of components that perform exceptionally well for the price, but aren't from the top-shelf. There's an Intel Core i5-6400T CPU that can encode video at 10.5fps (a little better than the 8.0fps of ultrabooks like the ASUS Zenbook 3, but less than the 15.1fps from gaming laptops like Dell's Inspiron Gaming 15). The unit's 8GB of RAM was less than we were accustomed to, but combined with the AMD Radeon R9 M470 GPU, it allows you to run older games like *GRID 2* and *Tomb Raider* at 1080p at averages of 36.2fps and 39.8fps with the settings turned up to Ultra. You'll even be able to play newer titles like *Batman: Arkham Knight* and *Far Cry Primal* above 30fps if you're willing to drop the graphics settings to Low or pair back from full-HD resolution.

For the most part, we think HP has done a great

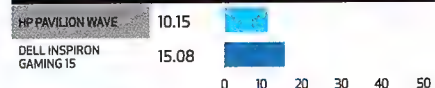
job of saving on components in ways that minimise compromise, but it's been some time since we've tested a PC without an SSD, so the boot times, transfer speeds and general responsiveness of the OS on the device's 1TB 7,200rpm HDD seemed sluggish and may leave you wanting an upgrade.

In most other ways, though, the HP Pavilion Wave is as elegant to use as it is to look at – and if the tower came with an SSD rather than an HDD, we'd be inclined to give it full marks. **Joel Burgess**

LABS BENCHMARK RESULTS

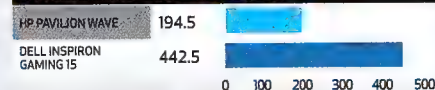
Media encoding performance

HWBOT X265 1080P (AVG FPS)

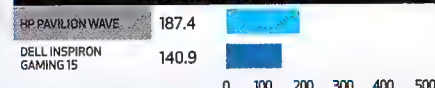


Storage performance

CRYSTALDISKMARK 5 - SEQUENTIAL READ (MB/S)

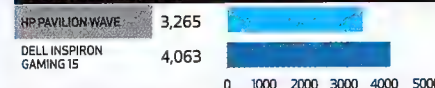


CRYSTALDISKMARK 5 - SEQUENTIAL WRITE (MB/S)

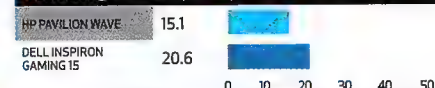


Gaming performance

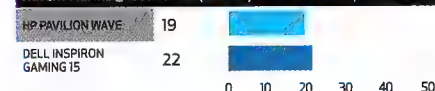
3DMARK FIRE STRIKE (SCORE)



THE DIVISION @ 1080P ULTRA (AVG FPS)



FAR CRY PRIMAL @ 1080P ULTRA (AVG FPS)



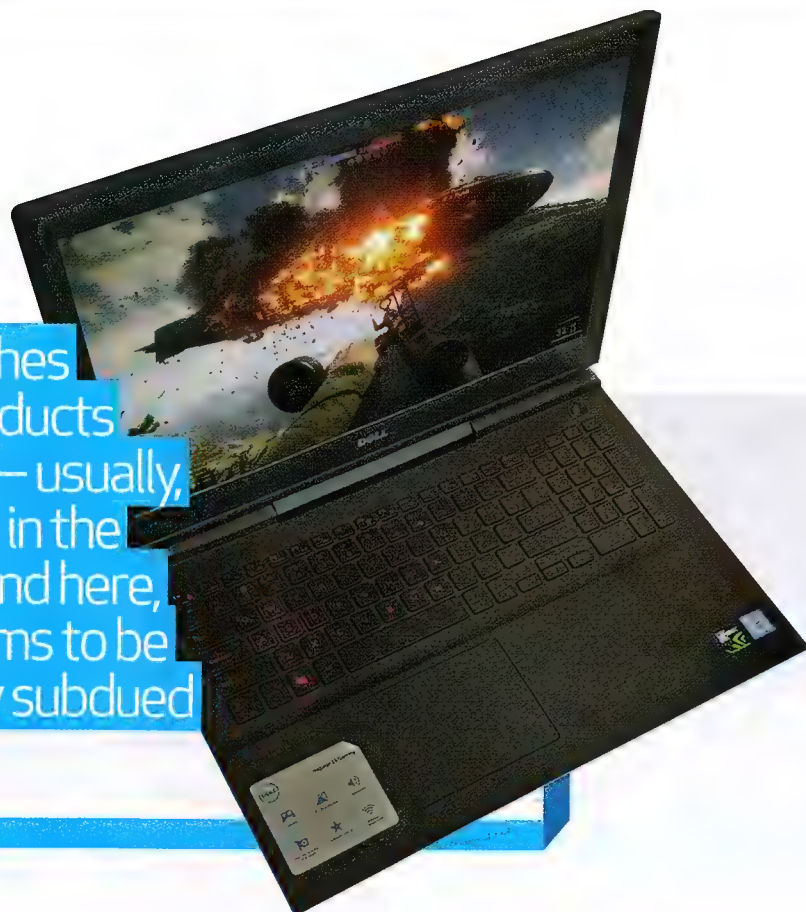
Verdict



It might not play games perfectly or come with a screen, but this little unit is attractive and amazing to work on.



"Dell only rarely launches 'gaming'-oriented products under its own name — usually, they're kept separate in the Alienware lineup — and here, the result of that seems to be that this is a relatively subdued gaming laptop."



GAMING LAPTOP

\$1,999 | WWW.DELL.COM

Dell Inspiron 15 7000 Gaming (7566)

A laptop that'll deliver long lasting gaming sessions — even on the go.

There really is no shortage of gaming laptops repping Nvidia's affordable and compact GeForce GTX 960M graphics chip. While Dell's new Inspiron 15 7000 is perhaps a little late to the party, this 15.6-inch gaming laptop isn't without its charms. It's not overly big, but nor is it particularly small. It isn't too brightly coloured, nor is it overly plain. And despite being full of relatively new hardware, there are parts of the fit-out that already feel well worn.

Dell only rarely launches 'gaming'-oriented products under its own name — usually, they're kept separate in the Alienware lineup — and here, the result of that seems to be that this is a relatively subdued gaming laptop. It has a powdery-black plastic exterior with hints of red in the keys, vents, backlight and topside logo. To the

trained eye, it's certainly a gaming laptop, but at the same time, it isn't overly ostentatious. Catering to both gaming and work audiences, it manages to include a silky and responsive trackpad, but the keyboard is unfortunately a bit shallow and mushy. The front-edge speakers are well positioned for watching media, but lack volume and their forward-firing nature means they're actually a little too far forward when you're sitting directly in front of the unit.

This model has a GTX 960M GPU but also a familiar Intel Core i7-6700HQ CPU, 16GB RAM, 128GB Toshiba M.2 SATA 6Gbps SSD, a 1TB Toshiba hard drive and a 15.6-inch anti-glare matte-finish 1080p display. That's reasonably run-of-the-mill in terms of hardware and so's the performance — this configuration pushes the same average scores as the similarly-specced MSI GE72

6QD Apache Pro and ASUS GL55VW laptops in the *Bioshock* (42fps), *GRID 2* (54fps) and *Tomb Raider* (50fps) benchmarks. Playable rates, sure, but a far cry from what you'll see in a 10-series laptop, like those we've reviewed on page 42.

In PCMark's accelerated Home battery test benchmark (with Nvidia's battery boost tech turned on and then again with it off) the PC gets close to 5 hours to a charge — a surprisingly lengthy span for a gaming device. The unit's cooling system is also well designed, keeping the CPU under 80°C and the GPU under 65°C, despite strenuous testing.

It's possible to play recent games like *Far Cry Primal* at an average framerate of 32fps on Normal detail settings, so you'll get a bit of mileage out of the GPU if you're willing to play current and upcoming titles at medium/lowish quality settings.

The Inspiron comes in two SKUs and though we feel the Core i7 processor (rather than an i5), additional 8GB of RAM and extra 128GB SSD on the model we tested seems more valuable than the \$300 saved on the cheaper unit, it still isn't a bargain at \$1,999.

Considering the formidable competition, an above-average battery life might not be quite enough to convince customers on its own. But then, at least the Inspiron 15 7000 Gaming has at least one thing it can crow about. ■ Joel Burgess

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

An office-appropriate workstation that'll handle new games on lower settings... a decent choice.





2-IN-1 TABLET

\$2,100 | WWW.HP.COM/AU

HP Elite x2 1012 G1

Another HP 2-in-1 that hews very-closely to the Surface blueprint.

If imitation is the sincerest form of flattery, then HP must really love Microsoft's Surface line of tablets. The Elite x2 is its second stab at putting together a Surface Pro clone, and it looks a lot like a premium version of that forebear – the Spectre x2. HP has a fairly wide selection of 2-in-1s in its portable lineup, and both this Elite x2 and the aforementioned Spectre veer more towards the 'tablet' end of the 2-in-1 spectrum – and even with just a glance at either, it's clear that HP has been working very closely from Microsoft's Surface playbook.

These are both 12-inch metallic unibody slates that include a fold-out kickstand in the back, stylus for writing and drawing and a detachable keyboard-cover that helps protect the screen when closed or turns it into a near-full laptop when unfolded.

But while the Spectre x2 was looking to undercut the

Surface Pro 4, the Elite actually looks like it's trying to match it – and it's certainly well-crafted. The general build-quality and sturdiness of this 2-in-1 are hard to deny, both on the tablet itself and the keyboard-cover.

If the Elite does have one main drawback, it's the size. It has a slightly bigger footprint – an extra centimetre to the Surface Pro 4's sides, coming in at 300 x 214mm (which is mostly just extra bezel) – but more critically, it's an extra 60% thicker, at 13.4mm vs the Surface's sleek 8mm.

The Elite's also heavier, at 840g vs 785g of the Surface. That all adds up to make a device that's, frankly, just a tiny but too big and unwieldy to use as a one-handed tablet, unless you're cradling it like a baby.

That bigger size does have some payoffs, however. It manages to squeeze in a lot of ports, including a full-size USB 3.0 port, a Type-C USB 3.1 socket (which also

doubles as the charging port and a microSD slot for expanding storage.

The keyboard in the cover is nice and large, too: it's almost as wide as you'll get on a 13-inch laptop (just a centimetre short of our MacBook Air's 'board) and the trackpad is big-enough that it doesn't feel cramped – although in testing, our review unit was a bit oversensitive to taps and we often found that we'd accidentally brush against it and send the cursor flying.

The display is mostly faultless, too – a bright and clear 12-inch IPS LCD using a 16:10 aspect ratio and coming in at a resolution of 1,920 x 1,280. It's protected by Gorilla Glass 4 – the same as what's used on modern flagship smartphones.

Having a fairly frugal Core M processor (our review unit had the midrange m5-6Y57), the Elite's general performance is more than adequate for basic computing and a little multimedia work, but push

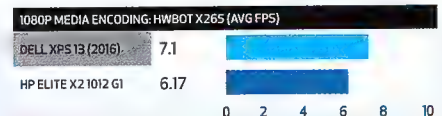
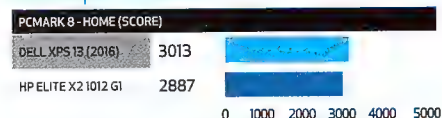
it too hard (like trying 4K video editing) and it will choke. We were also a little disappointed with battery life: despite that Core M chip, it only managed around 4 hours for productivity tasks. While that's about on par with the Surface Pro 4, it's a full hour shy of the Spectre x2.

It's a bit of a mixed result, overall, then. The bigger keyboard, handy variety of ports and solid build quality are all pros, but when you can have a higher-end Core i5 Surface Pro 4 for less than \$100 more, HP needs to do better on price... or at least up the specs to match.

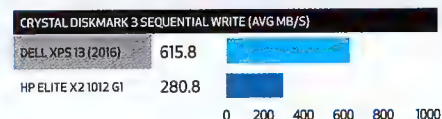
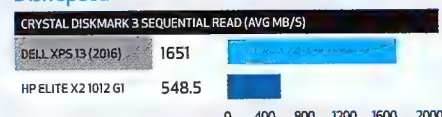
■ Dan Gardiner

LABS BENCHMARK RESULTS

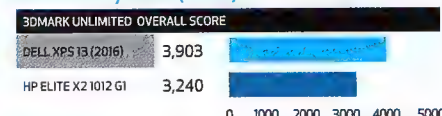
General performance



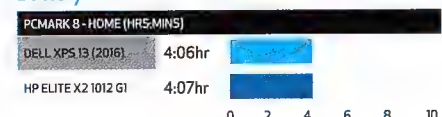
Disk speed



3DMark Sky Diver (score)



Battery life



Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

A well-built 2-in-1 with ample ports, but one that's a bit too expensive. Get the original Surface Pro 4 instead.

★★★★★

"Inside the 7710 are some of the best components available for mobile products."

✓✓✓
apc
RECOMMENDS



There's no disputing the calibre of the high-end components used in the Precision 7710, but we're not entirely convinced by the overall design.

WORKSTATION LAPTOP

FROM \$4,831.53 | WWW.DELL.COM

Dell Precision 17 7000 (7710)

There's a new sheriff in town, and he's packing a mobile workstation of epic proportions.

Dell took the risk and completely revisited its 17-inch portable workstation. Although we feel it didn't push the envelope as far as it could – it could learn from the XPS series – this shoo-in replacement for the M6800 sticks to what it does best: delivering the ultimate performance and using the best components in a portable form factor with little regard for budget.

Since this is a 17.3-inch model, it's heavy at just over 4.5kg with its 240W brick-like power supply unit – the device barely fits on an A3 sheet. It's also almost as thick as a ream of paper with its 35mm thickness.

Open it up and a 17.3-inch anti-glare backlit LED – linked to the base unit via two massive hinges – welcomes you. For displays, you can opt for a full HD IPS or a 4K IGZO panel.

You get a dedicated numeric keypad but you

lose the Home and End keys, and there are no dedicated function keys despite its size.

The keys themselves are slightly curved and mushier than we were expecting with decent feedback and barely any flex. We like the rubber finish of the palm rest which uses the same material as the cover. Other than the standard normal trackpad, the 7710 comes with a TrackPoint mouse stick, both of which are slightly eccentric.

Flip the laptop upside-down and you'll see the removable battery (either 72Wh with express charge or 91Wh), as well as plenty of air vents and a pair of speakers. Opening up the notebook is as easy as it gets and is done by removing two screws – that's great if you want to change any parts.

But what about the specs? Inside the 7710 are some of the best components available for mobile products. An Intel Xeon

E3-1575M processor – one with Iris Pro graphics, a 3GHz base speed and 8MB cache can be added for a cool \$2,502.50 – the base model has an Intel Core i5.

Designed to withstand the MIL-STD 810G certification, the 7710 also sticks to ISV certification, as you'd expect from a product sporting either a Quadro or a FirePro GPU. Including 64GB of RAM could cost up to \$1,180.

The base configuration is at 8GB or 16GB of RAM, the former can be quite restrictive.

As expected, the workstation offers multiple RAID options (RAID-0, RAID-1 and RAID-5). However, should you choose RAID-5, you must use M.2 cards. You can't have SATA devices, whether SSD or spinning disks.

The Precision 7710 feels like a compromised solution that doesn't quite deliver the goods. But it has great battery life, is very powerful and comes with

fantastic aftersales support. And there are only a few workstations (Lenovo ThinkPad P70 and HP ZBook Studio G3, to be precise) that can deliver 64GB of RAM, a Xeon CPU and a workstation-class GPU.

But it's much bigger (and heavier) than we'd like. The layout of the keyboard – as well as its size – is also likely to attract some criticism.

Dell should perhaps take a leaf out of its own XPS book and design something strikingly different.

■ Desire Athow

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

A solid workstation and a good performer, but we can't help but feel Dell could have done more.





ADSL/VDSL ROUTER

#929 | WWW.DRAYTEK.COM.AU

DrayTek VigorBX 2000ac IPPBX Firewall Router

A telephony and data powerhouse for small business.

While IP telephony has become the standard for enterprises, in the home and small business space, it's barely had any impact. Few router makers are still pursuing it, but if you're interested in IP telephony, there are still some manufacturers that provide capable solutions.

DrayTek's new VigorBX 2000ac modem router is a jack of all trades for small businesses, providing advanced routing and Wi-Fi alongside a built-in SIP server. It even has a VPN gateway service. It has a VDSL port and an Ethernet WAN port with load balancing in between them if both are connected. It can also support a 4G modem attached to a USB port, and that can be included in the load balancing schema. There are six gigabit LAN ports for client connections (no Power over Ethernet,

sadly), as well as some very advanced tools for port management, including features like LAN segmentation, content filtering and detailed quality of service options.

Full VPN client and gateway functionality is built in. The router has enough power and comes with enough licenses to support 32 simultaneous tunnels (and 16 SSL tunnels). It supports all the major protocols, too: L2TP, PPTP, SSL and IPSec.

However, when it comes to both router and VPN setup, you should be aware that, as with most DrayTek routers, setup and configuration is not for the uninitiated. There are no quick wizards, no easy mobile apps and no hand holding. You need to know at least a little bit about what you're doing to get it up and running, and it's the kind of thing that most small businesses will need a tech guy to accomplish.

The major selling point for a lot of people with this router is the in-built IP PBX capabilities. It supports up to 50 IP phone extensions that can feed into up to 12 SIP trunks.

As with the router functions, setup is a complex affair, but DrayTek has actually done a pretty great job of organising the many and varied functions of the IP PBX service, and we never had any trouble finding the element we were looking for. While you do need to be somewhat savvy to set it up, you don't need to be a master of Asterisk command line options, for instance.

It's certainly a capable system, offering much more than a simple call service. You can configure phone menu systems and automated 'robo-calls' with customer surveys. You can set up office hours and automated response systems when out of hours. There are dial plans, speed dialling and

call barring. It supports faxes, detailed call records (up to 1,000 calls) and can store voice mail messages on an attached hard drive or email them directly. It even has support for twin PSTN failover lines in case of a SIP failure, as well as a port for a conventional analogue handset in the style of a regular VoIP modem router.

Given all its capabilities, this really is a great one-stop solution for a small business looking to move to IP telephony solutions. Highly recommended.

■ Nathan Taylor

Verdict

Features	★★★★★
Performance	★★★★★
Value	★★★★★

A capable router, handy VPN gateway and neat IP PBX solution all in one, available for less than \$1,000.





Let
Nothing
Escape!!

HyperX Cloud Revolver

With its studio-grade sound stage and directional 50mm drivers, the HyperX Cloud Revolver lets you to hear your opponents' every move on the map. When your enemies have no place to hide, you can hear the cheers of victory.



HyperX Stinger



HyperX Cloud
Revolver



HyperX Cloud II

HYPERX
Real. Surround. Sound.

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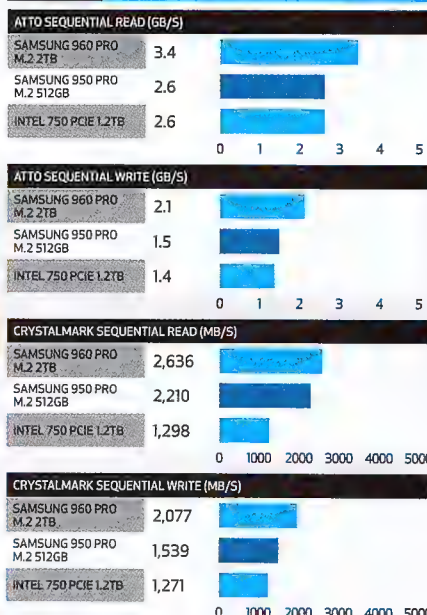
HOT PRODUCT



M.2 SSD

\$1,799 | WWW.SAMSUNG.COM/AU

LABS BENCHMARK RESULTS



Samsung 960 Pro M.2 (2TB)

The best SSD on the market just got better.

When solid-state drives first arrived, there was much rejoicing. The PC had crossed the final frontier. Mechanical devices could be banished, and with them performance bottlenecks.

But the first consumer SSDs had some serious performance flaws. Once those were hammered out, SSDs began to bump up against the limitations of the SATA interface and AHCI control protocol. Then PCI Express tech removed that bottleneck, and the NVMe protocol enabled even more responsiveness.

SSDs are still getting faster and that's the context into which Samsung's new solid-state killer arrives. Expectations are high, given the outstanding history of Samsung's Pro line of SSDs.

The 960 Pro is effectively Samsung's second-gen of consumer-targeted PCI Express SSDs in M.2 format, following the kickass 950 Pro, although Samsung did offer a few OEM M.2 drives

before the 950 Pro. The 960 Pro is pretty much all-new. It uses Samsung's latest Polaris controller chip, and it's also transitioned from Samsung's 32-layer 3D NAND memory chips to 48-layer chips, with double the data density.

The upshot is some stellar claimed performance numbers. The old 950 Pro was far from shabby, with its 2.2GB/s read rating, and max IOPs performance of 300k. But the new 960 Pro blows it out of the water. The 2TB model tops out at an epic 3.5GB/s for reads and 2.1GB/s for writes.

The QD32 random access numbers are almost as impressive, at 440k read IOPs and 360k write IOPs. The latter figure is well over three times the official 110k write IOPs of the 950 Pro. As if that wasn't enough, the endurance rating is up, too, and rocks in at a beefy 1,200TB. But not all the numbers are as spectacular. Samsung has only managed an incremental improvement in QD1

random access performance. But as a whole, it's a huge leap over what was already a lightning-fast drive.

In some regards, that's how it plays out in our benchmarks, too. In ATTO Disk Benchmark's raw test of throughput, the 960 Pro demolishes data at roughly the claimed multi-gigabyte rates. It's much quicker than the 950 Pro in CrystalMark's sequential tests, too. Elsewhere, though, the 960 Pro is very fast, but not as big a step forward as we'd hoped. It only improves on the 950 Pro's 51MB/s CrystalMark 4K reads by 7MB/s, for example. And it's actually a little slower than the 950 in CrystalMark's 4K write tests. The 960 Pro is likewise barely any quicker in our real-world file copy test than either the 950 Pro or Intel's 750 Series 1.2TB drive. We also had the same issues with 4K benchmarking in AS SSD that we saw with the 950 Pro. You could write that off as a quirk with that particular benchmark, but

it's difficult to be certain that there aren't real-world workloads that would trigger the same issues.

It's one of those weird situations where we have a product that's probably faster than anything we've seen previously. At 2TB, it's also a reminder that, soon, you won't need a magnetic drive. And yet, somehow, the 960 Pro leaves us less than totally convinced. It's probably the best drive you can buy at the moment. But it's still not perfect.

It's also worth noting that Intel's 3D Xpoint tech is coming, and might just revolutionise storage tech.

■ Jeremy Laird

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Fantastic specifications, mostly awesome performance and huge capacity. But ow, that price smarts.





2-BAY NAS BOX

\$1,549 | WWW.WD.COM

WD My Cloud Pro PR2100 (16TB)

Versatile storage for the cloud generation.

The popularity of network-attached storage is perfectly illustrated with this latest release from Western Digital: the My Cloud PR2100 is essentially an upgraded take on last year's My Cloud Business DL2100 — a device that was aimed squarely at small businesses. This new device uses the same chassis, with its austere and utilitarian drive bays, but updates the innards so that it can handle 4K streaming.

The PR2100 is a dual-drive unit — the PR4100, a four-bay device, is also available. Both units boast the same core hardware of a quad-core Intel Pentium N3710, coupled with 4GB of DDR3. This CPU has a base frequency of 1.6GHz, capable of bursting up to 2.56GHz if needed, although it's the low TDP of just 6W that's possibly more noteworthy — you'll rarely

call on the full performance of the chip, but you will leave the unit plugged in 24/7. In testing, it pulled just 22W from the wall, which is impressive.

One thing that we noted with the original DL2100, and something that continues to grate with this model, is how noisy it can be. We're not talking about the bump and grind of the hard drives, which isn't much more noticeable than other NAS units, but rather the whine of the fan at the rear of the unit. This is loudest when it's first turned on, but revs up at other times, too. It could well limit where you place the NAS.

On the positive side, this device is incredibly easy to set up: plug it in, connect it to your router, turn it on, go to the My Cloud website and you're up and running. The main drive interface is simple but slick. Accessing the drive locally is as straightforward as you'd

expect, while connecting to it over the internet is also surprisingly easy. Uploading files remotely can be a sluggish affair, but pulling that data off is snappy, and local uploads are much quicker. In testing, we witnessed local read and write speeds of 119MB/s and 118MB/s, respectively, which are both very healthy.

The PR2100 is available as an unpopulated device with a list price of \$669, but the model we have here ships with a pair of Western Digital's own 8TB Reds. These drives cost \$472 each on their own, so buying this drive populated represents reasonable value for money as well. By default, these are configured as a RAID 1 volume, which makes sense for a two-drive device that you're trusting with your data. This gives you 7.93TB of space to play with, and has the reassurance that comes with a mirrored array. It also supports JBOD,

Spanning, and RAID 0 configurations as well.

One particularly nice feature is the front-mounted USB port that enables you to back up the contents of whatever you plug into it with a touch of the button above the port. It's a simple idea, but one that's often overlooked by bigger, cleverer devices. There are 17 apps for the My Cloud Pro, covering everything from media servers to torrent clients, though — so, for the vast majority of uses, Western Digital should have you covered. ■ Alan Dexter

Verdict

Features	★★★★★
Performance	★★★★★
Value	★★★★★

Versatile connectivity, push-button backups, good performance, plenty of apps, reasonably good value.





4K MONITOR

\$888 | WWW.AOCMONITORAP.COM/AU

AOC U3277PWQU

It's 4K. It's beautiful. But is it future-proof?

The last year or two have seen a constant flow of innovation. High refresh rates, frame synching, tumbling response times—it just keeps coming. HDR displays are also expected to make the jump from the HDTV market to the PC. And it's into that acutely demanding context that AOC's U3277PWQU steps.

At \$888, it's surprisingly affordable, which demands the question of how it stacks up from a raw specification perspective, and what future-proofing it provides.

The headline numbers are impressive. It combines a 32-inch diagonal with a full 4K pixel grid. That's 3,840 x 2,160 pixels. For gaming, it's probably too many pixels for most GPUs. Right there, you're buying into the future. One day, 4K will be perfect for the latest graphics cards.

The U3277PWQU also sports frame rate control (FRC) technology to enhance the colour depth of the 8-bit

panel, and boost the nominal 16.7 million colours to a full 1.07 billion. In that sense, it offers at least a slice of the upcoming wide-gamut and HDR action that's already revolutionising HDTVs and console gaming. With both DisplayPort and HDMI 2.0 connectivity, it's also a flexible partner for a wide range of devices.

But that's it. There's no 120Hz-plus refresh, no G-Sync or FreeSync and no full HDR support. When you fire up the U3277PWQU, however, you might find you don't care. This display is gorgeous. Part of that is down to that combination of a generous 32-inch diagonal and the 4K resolution. It makes for a nice, tight pixel pitch, but also allows you to use 100% scaling in Windows and maintain reasonable legibility.

It's also down to the fantastic VA LCD panel. IPS panels get all the love these days — justifiably so in many regards. IPS is the most accurate LCD technology, and delivers the best

viewing angles. But when it comes to visual pop, colour saturation, contrast and black levels, VA cannot be beaten. Which is why the U3277PWQU looks so stunning. You don't get deep inky blacks like this with IPS panels.

What's more, it's nicely calibrated out of the box, with both black and white scales showing lots of detail. Elsewhere, the news is mostly good. Pixel response, often a VA weakness, is reasonable, thanks to user-configurable overdrive technology, and the viewing angles are decent.

The chassis is a nice bit of work, too. Until recently, AOC was seen as a budget brand. But it has seriously upped its game. This feels premium, from bezel tip to the foot of its multi-adjustable stand.

The anti-glare coating suffers from a little sparkle. Surprisingly, a whiff of banding is visible in colour gradients, too. So much for those billion colours... But we're splitting hairs.

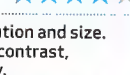
Whether it's 4K video or games, everything looks fantastic.

All of which makes it a seriously appealing proposition, slightly tempered by the knowledge of what's just around the corner. Admittedly, that's pretty much always true for any technology. At this price point and this moment in monitor history, however, that's particularly true. If you are buying today and the U3277PWQU fits your budget, it demands your attention. But know this: Things may look very different 12 months from now.

■ Jeremy Laird

Verdict

Features
Performance
Value



Nice balance of resolution and size, stunning colours and contrast, and good build quality.





GAMING HEADSET

\$120 | EN-AU.SENNHEISER.COM

Sennheiser GSP 300 Gaming Headset

Seriously loud, seriously light.

We bolted on Sennheiser's sexy-looking middle-ground cans, and steadfastly refused to remove them for six-to-eight hour stretches, alternating between marathon *Overwatch* sessions, pumping music and generally blocking out the rest of the office.

There's rarely been a headset so well designed. The GSP 300's memory-foam ear cups, coated in silky faux-leather, positively caress the skull, combining with the closed-back design – hinged on to ball joints, which place the cups squarely on even the most angular head – and block out external sound well. You're not entirely in your own world, of course. Our colleagues, we assume from their wild gesturing, experienced mild second-hand discomfort when we blared the thrash metal, but there's no more leakage than most closed-back units.

They're also light, to the extent that we legitimately

thought Sennheiser had accidentally sent us an empty box when they hit the office. But we have no concerns about their durability. They're also easily adjusted. Plus, swing the mic to vertical, and it shuts off.

Sennheiser has crafted an interesting rich, bass-heavy, bouncy sound, which is incredibly appealing on first listen, and at high volumes. Almost everything, not just the bass, feels marginally boosted, leaving no sound to the imagination.

The mic is adequate for streaming or recording, but we'd lean toward a dedicated external mic if we were going for a pro finish. This is a quality headset, a notable notch above budget options.

■ Alex Cox

Verdict

Loud, so loud; immensely comfortable, with on-ear volume control and a decent mic.



GAMING KEYBOARD

\$189 | WWW.COOLERMASTER.COM

CoolerMaster MasterKeys Pro L White

It will shine on any desk.

CoolerMaster has designed a 'board with very bright, plain white backlighting, rather than sporting millions of colours (although these are available, too, if you must). Those large, bright LEDs come as a result of a redesigned PCB. The microUSB cable is a removable affair and the Windows key has been rebranded the CoolerMaster key. Nice.

The Pro L gives the impression of having a lot of keys but not much board. The keys on our model had Cherry MX Brown switches (Blues and Reds can also be fitted). Above the numeric keypad (a tenkeyless 'S' version of the keyboard is available), there are four P keys, while at the right of the space bar, you'll find a Fn key very much like that found on laptops. Using this as a modifier, the F keys control every aspect of the keyboard, without needing to go into the bundled software, enabling you to

alter the lighting and repeat rate, and record macros, along with switching profiles. Holding down Fn gives a readout of the keyboard's current settings, too – a thoughtful addition.

Inside the Pro L sits an ARM Cortex M3 processor, a 32-bit chip, ticking along at 72MHz. It's not hugely powerful, but it's enough to make the Pro L feel snappy in use, with no lag.

The Pro L is well built and looks the business with its matte-black exterior pierced by its brilliant white LED lighting, but its main problem is the competition. It's priced in a bracket that puts it up against keyboards from the likes of Logitech and Razer, and sadly, the CoolerMaster is likely to be overlooked.

■ Ian Evenden

Verdict

Good keys, bright lights, plenty of customisation, but lacking a little oomph to see it over the line.



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WIRELESS GAMING HEADSET

\$399 | WWW.STEELSERIES.COM

SteelSeries Siberia 840

Are we witnessing the best wireless headset?

It's a widely held opinion among tech journalists that if you're after the best wireless headset money can buy, the SteelSeries H Wireless is your best bet. So with the launch of the Siberia 840, an updated variant of the H Wireless, we had to get our hands on it to see what had changed.

The soft foam padding at the top of the band is still exceptionally comfortable, and you still get two interchangeable batteries included with the charging dock. The dock is also almost identical we well, supporting a variety of EQ adjustments, and with many options for audio out.

But there's been a slight adjustment to the overall aesthetic design. Instead of plain plastic ear cups, you're now greeted with a faux brushed aluminium metallic finish. Bluetooth has also been included and really impresses. On top of that, the company has integrated support for its SteelSeries Engine desktop software, so

you can control your profiles and EQ settings on your rig, as opposed to on the dock.

How does it fair as a headset? Pretty damn good. The audio quality is exceptionally well rounded. It could do with being a touch crisper on the upper end of the treble, for the sake of clarity.

The omnidirectional mic does a swell job of ensuring little background noise is heard, and your voice remains crisp and clear. Range is a good 6m and battery life is roughly 16-20 hours, depending on usage and volume.

\$400 is a lot for a headset. The 840s are impressive and provide wireless freedom but lack the audio quality of something more traditional.

■ Zak Storey

Verdict

Comfortable, compact, intuitive battery solution, Bluetooth capability and dependable audio.



WIRELESS GAMING HEADSET

\$179 | WWW.ASUS.COM/AU

ASUS RoG Strix Wireless Gaming Headset

Hegwig, is that you?

Those bright-orange owl-like eyes glare outwards from the side of your head, meaning you'll likely be the subject of some rubbernecking if you wear these outdoors.

The cups are nice and large, catering to ears of all shapes and sizes, and the leather-covered memory foam is very comfy on the cups and expanding bridge, which is a lot more sturdy than other models we've seen adopting this design. We do wish it'd allow for smaller-sized noggins, though. The hard-plastic design does mean they can creak a little when you move your head around, which annoyingly serves to break the immersion at times.

At 350g, they're not quite light enough to forget you're wearing them, but they do remain comfortable for lengthy periods of time.

The detachable unidirectional mic is easy to slot in and adjust, and four buttons on the left cup control the volume, mic and

power. Connecting to a device is super simple and they'll last around 10 hours after a full charge.

In-game (testing with *Skyrim* and *Half-Life 2*), they performed well, and the 7.1 virtual surround sound means that explosions sounded meaty, scuttling headcrabs were creepy and arrows whistled nice and sharply past our ears. All genres of music also seem to be quite well balanced with no distinguishable distortion. ASUS's Sonic Studio software also lets you tweak the sound a bit.

There's no noise-cancelling magic here, and turning up the volume will drain the battery faster, but they're a good set for their intended PC-bound purpose.

■ Carmel Sealey

Verdict

The design won't be everyone's cup of tea, and the creaking will grate, but they do the trick.





GAMING MONITOR

\$999 | WWW.AOCMONITORAP.COM/AU

AOC AGON AG271QG

Have some 165Hz IPS awesomeness from AOC.

There's a lot going on in the monitor market right now. 4K, curved panels, the promise of HDR – it's all happening. But that doesn't necessarily mean the sweet spot for a high-performance PC monitor, with a bit of gaming in its remit, has changed.

The new AGON AG271QG is part of AOC's new high-end line of gaming-centric PC monitors, and it checks an awful lot of our boxes. For starters, it's a 27-inch model, with a 2,560 x 1,440 native resolution. That's a very nice compromise between size, detail, desktop space and GPU load.

In fact, it's probably the best all-round compromise right now, especially if you aren't a fan of multi-GPU gaming. Even Nvidia's latest Pascal graphics cards are marginal when it comes to driving 4K resolutions really smoothly. That's particularly relevant when you consider the AG271QG's support for refresh rates of up to 165Hz. There's zero

chance of playing the latest games at that kind of frame rate at 4K. So that WQHD resolution gives your GPU half a chance of punching out frame rates to do the 165Hz support something approaching justice.

On those occasions when your GPU can't crank out triple-digit frame rates, the AGON also has a solution in the form of support for Nvidia's performance-smoothing G-Sync tech. Factor in a few frills, such as the handy headphone hook on the right-hand side and the fully adjustable stand, and you have a very nice overall gaming package on paper. AOC even includes a handy mouse-sized programmable controller that helps you quick-jump between settings.

As if that wasn't enough, we haven't even mentioned the kicker – the IPS tech used in the LCD panel. Yup, that's 165Hz refresh and lovely IPS colours, just like the ASUS RoG Swift PG279Q, but for about \$200 less. Where do we sign up?

Fire the AG271QG up and initial impressions are good. The IPS panel has a super-smooth anti-glare coating, and thus clean, sparkle-free image quality. The viewing angles are pretty much impeccable, too. Gradients are ultra-smooth, and there's tons of detail in the white scales. Only a whiff of compression in the black scales spoils what would otherwise be a perfect score.

That 165Hz refresh is just to die for, and makes for a really responsive screen and solid-looking images. It's so nice, we'll forgive the fact that you have to dig into the OSD to enable a silly overclocking mode to get at the highest 165Hz setting. At least the menu is clear and simple to navigate.

One arguable downside of IPS technology in a gaming screen is pixel response. The AG271QG is rated at 4ms, which is a little off the pace of 1ms TN panels. But for most gamers, we doubt they'd notice the very slight increase in blurriness. What they will pick up on is those

gorgeous IPS colours and superior contrast. If you're looking for downsides, the AG271QG can't compete with its ASUS nemesis when it comes to perceived quality. The chassis feels relatively cheap, and the adjustable metal stand is a bit of a lash-up compared to Asus's slick efforts.

But then the AOC is quite a bit cheaper, and such shortcomings have diddly-squat to do with image quality, productivity, or gaming fun.

In all, the new AOC AGON AG271QG is certainly a very plausible new competitor in the performance 27-inch segment. ■ **Jeremy Laird**

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Gorgeous IPS panel, awesome 165Hz refresh, tons of gaming-friendly features.





\$120 | WWW.RAZERZONE.COM

Razer DeathAdder Elite

It's the return of the king... again!

The DeathAdder design has remained popular and in production since 2006. It's seen many upgrades over the years – the last at the end of 2014 with the Chroma edition – so it's due for another.

But how do you make an already-great mouse better? Razer's answer has been to improve the build quality and durability by swapping to mechanical button switches and a 16,000dpi optical sensor. For most players, that upper limit won't even be touched, but those new switches provide a firmer, slightly more stable feel to clicks, and they're a bit quieter too.

Razer's also changed the textured rubber used on the scroll wheel – rather than being made up of grooved horizontal ridges, there are now evenly-spaced sets of three raised nodules. That does seem to increase the overall grippiness, but isn't quite as comfortable as old ridged design. There's also a set of DPI switching buttons

behind that wheel, so you can now change sensitivity on the fly. Finally.

Tracking performance is unimpeachable; in testing, we were able to be as accurate on this mouse as with the Chroma. That said, at our preferred 1,800dpi setting, there's not a lot between them.

For now, the Elite's only available in a right-handed design, and it's still a very lightweight mouse at 105g, so if you're a lefty or you prefer a heavier mouse, you should look elsewhere.

For everyone else, this is the best gaming mouse on the market. At present, you'll pay an extra \$40 for it over the Chroma, but if you can wait a few months, that'll undoubtedly come down a bit. ■ Dan Gardiner

Verdict

Our favourite gaming mouse just got better, but if you already have a Chroma, probably keep it.



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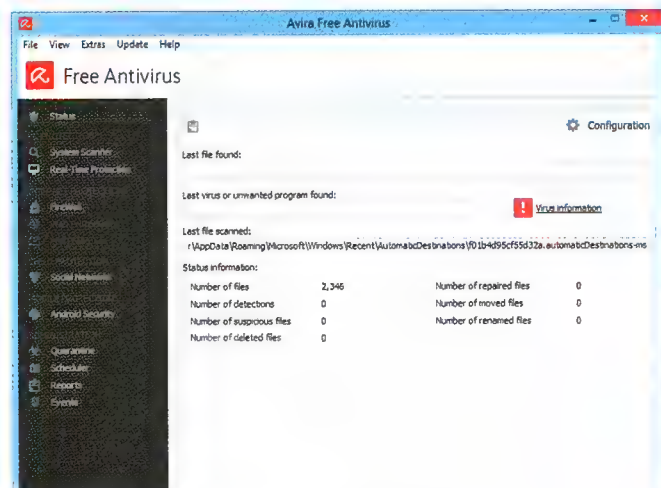


Antivirus developer Avira has launched a new all-in-one online security bundle for 2017 – and it's completely free. Avira Free Security Suite includes Browser Safety, System Speedup and VPN tools, plus the updated edition of its antivirus software.

Browser Safety comes in the form of a browser plugin for Chrome or Firefox that places icons beside search results to indicate whether they're safe to click, helping you avoid threats like phishing sites.

The version of System Speedup bundled in Free Security Suite is actually a 30-day trial of Avira's premium optimisation tool. It gives sluggish PCs a boost by removing unused files left over by messy software uninstallers, cleans up your Windows registry and lets you manage running processes. There's also file encryption and secure shredding, a built-in backup tool, file recovery and a network manager.

Like any VPN service, Avira Phantom VPN prevents your activities being tracked by third parties (including unscrupulous online advertisers), prevents your personal data being intercepted, and lets you access location-blocked content from anywhere in the world.



The free edition of Phantom VPN gives you 500MB data transfer per month but you can upgrade to the premium tier with unlimited data from €5 per month (about AU\$7) when billed annually. **Cat Ellis**

LastPass

Our favourite password manager just became free.
FREE | WWW.LASTPASS.COM



The affordable premium tier of LastPass, offering broad platform availability and multi-device account syncing, has been our best password manager for the last few years, consistently winning awards in our round-ups. However, the most valuable feature of this password manager service was the multi-device syncing which, until now, was restricted to LastPass Premium, which required a US\$12 per year subscription. In an interesting attempt to gouge out a bigger market share, the company recently decided to make the multi-device syncing feature available to its non-paying users. Now, all LastPass users can manage all their account logins and sync them across an unlimited number of devices running Windows, macOS, Linux, iOS or Android. Nothing else in the free tier seems to have changed, with password generation, unlimited password storage, auto form filling, security audits and multifactor authentication features are still included. The cross-platform service is available to all new users immediately, and if you already have a LastPass account, just install the appropriate app on your other devices and you'll find all your logins can be synced automatically. **Cat Ellis & Joel Burgess**

Microsoft Teams

Bringing all of Office 365 into a single chat app.
STBA | TINYURL.COM/APC436-MTEAM



Microsoft hasn't been sitting idly as Slack and HipChat have become the defacto kings of online workplace collaboration. The Redmond firm has finally announced the long-rumoured Teams app, a familiar-looking answer to chat services that leverages Microsoft's Office 365 apps and services. Teams brings the entire Office 365 suite together under one app — and in a high-identical interface to Slack, albeit with some key improvements. Teams is available right now in a 'customer preview' edition, with general availability due within the first quarter of 2017. Microsoft Teams has the basics well covered. General chat rooms are available, as are 1:1 conversations between team members. Users can even create custom channels for specific tasks and invite individuals, and they can search across channels, team members and files — just like Slack. Teams also offers an inbuilt custom polling tool to easily take team members' reactions to a given idea, subject or whatever, really. The key advantage of Teams is its integration of just about every Office 365 app and service, allowing it to become the hub for any professional Office 365 user. **Joe Osborne**



Mac » APPS

Live Home 3D

Design your dream interior the easy way.

\$46.99 WITH IAP | BELIGHTSOFT.COM



If you've ever fancied remodeling a room in your home, but haven't a clue how to go about it, then you need to try Live Home 3D. This makes the process of designing a new house or interior so deceptively simple and fast.

If you have existing blueprints for your dream home, it's easy to import scans and create a detailed 3D model, with furniture and all the trimmings, or start from scratch using the software's intuitive tools to throw up virtual walls, windows and more. Live Home 3D displays measurements for each room, which can be assigned custom names. The Room tool makes it super easy to draw a complete space, then attach it to any part of the house. There's even a slick drawing tool for adding rounded walls in a few clicks.

The user interface is laid out in a comfortable and logical tabbed style, which turns what could be a rather daunting task into a whole lot of drag-and-drop fun. One area where there's still room for improvement is how Live Home 3D handles layers, it becomes a challenge as houses grow in size, and there's no way to easily search through elements.

Although it handles basic landscape design, it's not adept at it, especially if your planned home is on anything other than flat ground. It's much better at sprucing up digital homes with a library of over 1,500 objects, which can be decorated with more than 2,100 different built-in materials; if that's not enough, an optional Extras Pack adds another 600-plus materials.

When the house is complete, you can take a virtual 3D walkthrough, export projects to social networks or even share 360° panoramas directly to Facebook. The developer provides detailed video tutorials to help get started, and there's a free trial version to get a flavor of the software before you decide. There's also a Pro version (\$109.99, or \$62.99 upgrade from non-Pro version) available for those who want to tinker with structures taller than two stories or require more complicated roof, balcony, or porch designs.

In all, Live Home 3D makes designing your dream house easy and fun. **JR Bookwalter**



iMazing 2

Back up iOS without iTunes.

FROM \$49.99 | IMAGING.COM



iMazing 2 provides an alternate method for backing up and restoring mobile data on any iOS device running iOS 5 or later. A Mac (or PC) is required, but iMazing works with USB or Wi-Fi connections; the former is preferred, since it's much faster. In addition to backups and drag-and-drop data transfer to or from your iOS device, iMazing's neatest trick is the ability to copy from an older device to its new replacement. We used it to clone from an iPhone 5 to iPhone 6s Plus — it was a mostly seamless process that makes you wonder why Apple can't make it this simple in the first place.

iMazing has another leg up on iTunes — you can choose to store backups anywhere, freeing up internal storage. Archived backups are optimised to reduce the amount of space required, and can be automatically purged at user-selected intervals. Step aside, iTunes — iMazing 2 is now the most versatile way to back up and transfer content to or from your iOS devices. **JR Bookwalter**

Archiver 3

A to Z of compression from Amiga to Zip.

\$30.99 | INCREDIBLEBEE.COM



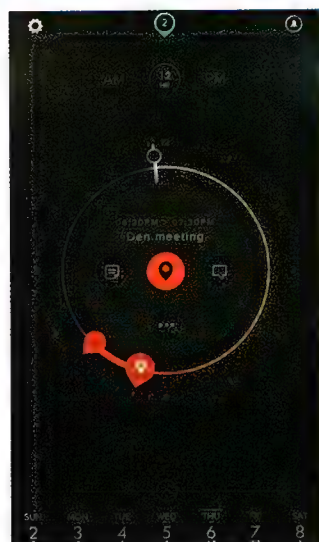
If you've ever wondered what to do with a Tar, Gzip or a RAR; needed to compress specific kinds of files; or just want to pack more files onto your drive, Archiver 3 is for you. It compresses and decompresses more than 30 file types. But it can also split compressed files and compress them again to make them even smaller, you can Quick Look at the contents of archives and app bundles before expanding, plus encrypt files to keep them safe and extract multiple archives simultaneously. It even has its own compression format for media files.

The interface is super user-friendly and it's very flexible. If you spend a lot of time shrinking things for storage or sharing, it'll save you countless hours, and if you're sending things online, it'll reduce your bandwidth usage. If you only need to merge the odd RARs, then go for something free, but if you're constantly compressing, it delivers a lot of bang for buck. Who knew file compression could be so much fun? Archiver 3 is a real timesaver. **Gary Marshall**





App Store » iOS APPS



Dials Calendar

A new way to keep a rounded schedule

FREE | DIALSAPP.COM | IOS 9 OR LATER

There are plenty of great calendar app options — Fantastical 2, BusyCal and Calendars 5 are three of our favorites. But for those in search of something exciting and fresh, check out the new kid on the block. Dials Calendar offers a completely different experience, one that substitutes the traditional day/week/month view you know and love with a clock-based design. The dark UI definitely takes some getting used to, with events appearing as colour pins placed around a dial at scheduled times; tapping a pin displays additional details for that event.

By default, the home dial provides a peek at the next 12 hours (there's no way to view all 24 hours at once), with a running countdown to your next event; you can also switch to time or date views. A tap or swipe puts the focus on only morning or evening events, and the weekly calendar across the bottom can be expanded to reveal the entire month.

This approach starts to make sense when assigning event times, which is done by dragging start and end pins around the dial. But it's a little more awkward with all-day events. One nice touch is how Dials integrates with Contacts and Maps, providing visual flair by showing photos of the people you're scheduled to meet with, as well as the location.

The result is a calendar that can be navigated using your thumb with the device held in one hand, which mostly works even on larger devices like the iPhone 7 Plus. (Dials can be installed on an iPad, but sadly lacks native display support for tablets.) The app can be used independently with a Dials account, or synced with major cloud services such as iCloud, Google and Outlook/Exchange.

Dials Calendar isn't for everyone, but its 'rock around the clock' approach is unique, and shows itself to be useful for one-handed use. We'd like more display options, though.

JR Bookwalter

Mondly

Converse your way through language learning.

FREE WITH IAP | MONDLYLANGUAGES.COM | IOS 7 OR LATER



Duolingo has garnered a well-deserved reputation as one of the easiest ways to learn new languages on a mobile device, but it's not the only game in town. One of the fastest rising contenders is Mondly, which offers interactive lessons in 33 different languages — more than any major competitor.

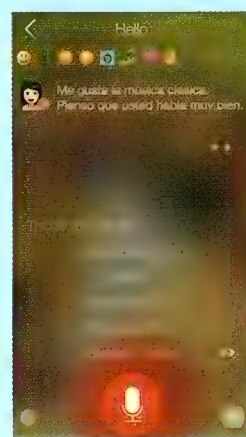
Mondly is a Universal iOS app (also available as a web app) divided up into 17 conversation modules. The service is designed to help those who have trouble memorising words and phrases with traditional methods. The Hello category is free in all available languages, and users can dive straight in without having to sign up for anything.

The app uses a series of games to learn new languages, but the fun doesn't have to end there if you're not into the idea of purchasing the in-app upgrades (available in bundles starting at \$8.99). The Daily Lesson provides a new opportunity to learn every day, whether it's memorising

words accompanied by a photo or guessing the correct sequence to short phrases.

New to version 5.0 is Mondly's Chatbot, a Siri-style interface for practicing conversations. Mondly will first say something in the chosen language, then help guide you toward the correct answer, which is entered with a tap-and-hold on the microphone button. Chatbot uses speech recognition from Nuance, so it's highly accurate and a whole lot of fun to use.

JR Bookwalter



Timelines

Keep on top of contract work.

\$7.99 | TIMELINESAPP.IO | IOS 8 OR LATER



If you're a freelancer, you'll know how hard it is to keep track of which client you're working for at any given time, and for how long. With Timelines, you need only tap a button to start or stop time tracking in a chosen category. An unlimited number of these so-called 'timelines' can be set up to track multiple clients, projects, hobbies and more.

Once a tracked event has been recorded, you can add a note or assign a title. Colour-coded data appears on a scrolling timeline, and zooming into a given day or time period is just a pinch away. The app is amazingly intuitive and easy to use, although the nature of its horizontal scrolling makes Timelines best suited to landscape mode, and having a larger screen will certainly help.

Visually rich statistics are just a tap away, too, with a pie-chart breakdown and details on how much time was devoted to each timeline. These stats can also be exported.

JR Bookwalter



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Light Moderate Heavy

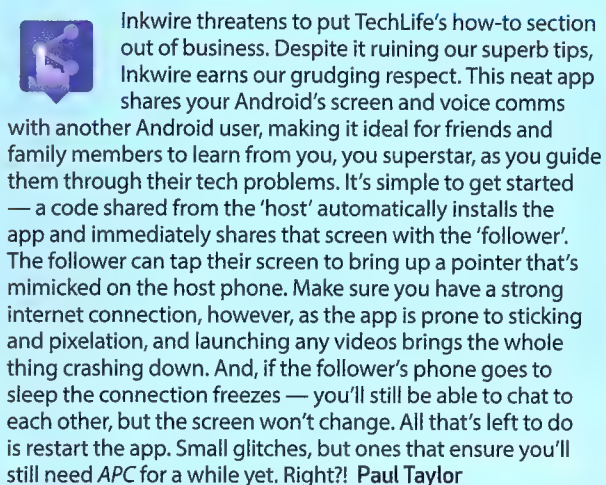
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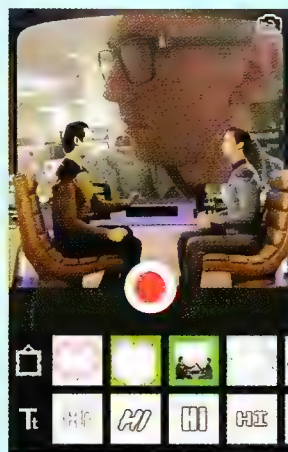
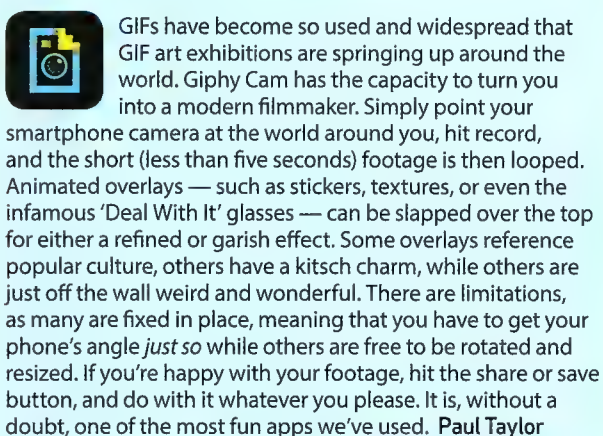


Smartphone screen-sharing
FREE | INKWIRE.IO



Putting the LOL into your GIF

FREE | GIPHY.COM/APPS





Linux » OPEN-SOURCE SOFTWARE

Feh

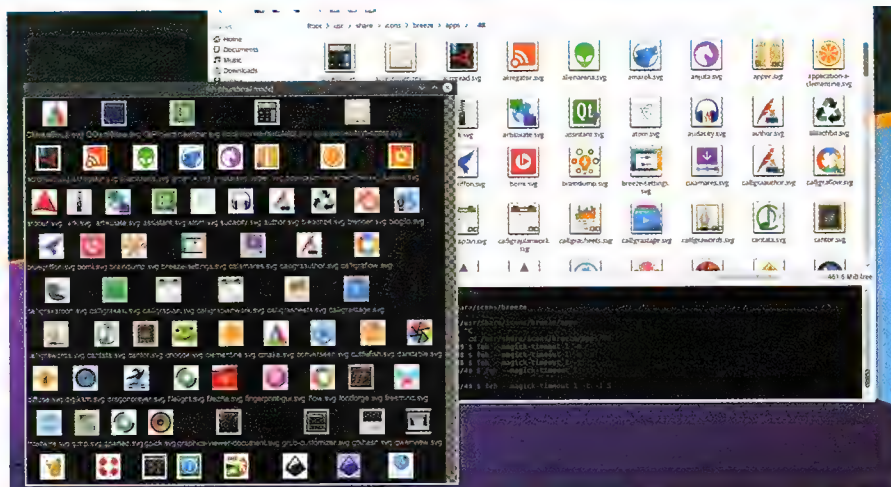
Yes, that's its name.

FREE | [GITHUB.COM/DERF/FEH](https://github.com/derf/feh)

Feh is an image viewer that gracefully complements a purist's desktop environment. The app is a console loader of various graphic formats based on the Imlib2 library. This library, in turn, supports nearly 14 bitmap formats through its 'loaders', including JPEG and PNG.

In real-life use, we've found Feh to be super-fast and very simple for a command-line application. If launched without arguments, it displays all images found in the current directory.

Feh has a vast list of available options, so you can do many amazing things with it, especially when used in a script. There are numerous practical examples of simple one-liners that may attract you to using Feh. For example, if



you work in an X11 session with a simple window manager such as Openbox, Fluxbox or Xmonad, you can set a wallpaper using Feh: `# feh --bg-fill /path/to/image`. Other variants such as `bg-scale`, `bg-max` and `bg-tile` will also work. The Feh manual only briefly lists all available options, but you can learn how to make

slideshows, display superimposed text captions over images, view all images in a thumbnail mode, fetch images from a network, preload a large number of images to Feh's cache and much more. This app receives monthly updates and is implementing more and more new features with each release.

Alexander Tolstoy

KolorManager

Get this 'kool' (and free) colour calibration tool.

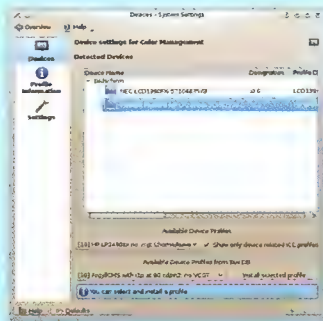
FREE | [BIT.LY/KOLOMANAGER](http://bit.ly/kolormanager)

KolorManager is a front-end to libXcm with a nice, easy-to-use integration into the Plasma desktop. If your work includes colour correction of still images or videos, you will benefit from using colour profiles with your Linux workstation. The X Color Management specification, its reference implementation (libXcm) and GUI (KolorManager) refer to a well-established list of supported imaging device categories: displays, scanners, printers and cameras. KolorManager supports industry-standard ICC colour profiles, which are often available from manufacturers of these devices. By adjusting colour profiles of each device, you can make colours of a printed image look very similar to colours on the screen. KolorManager assigns ICC profiles to calibration states of colour devices, so to get as close to the device behaviour that was present during its ICC profile creation. You can also assign different colour spaces (profiles) to different documents and applications by having

CMS running in the background of a Plasma desktop and by KWin, which handles windows.

The project offers binaries for Debian, openSUSE and Fedora, while the rest of the distributions (distros) may occasionally provide KolorManager in their repositories as well.

Alexander Tolstoy



Ungoogled Chromium

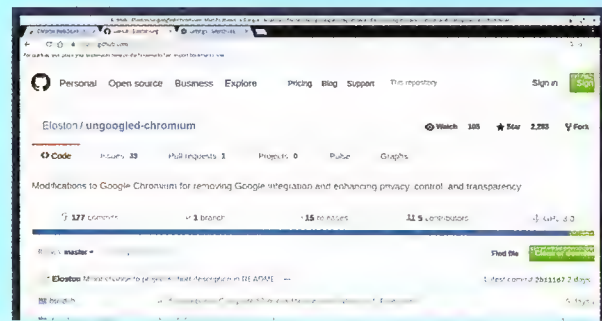
Chrome gets stripped of the corporate bits.

FREE | [BIT.LY/UNGOOGLEDCHROMIUM](http://bit.ly/ungoogledchromium)

This is a Google Chromium variant intentionally lacking Google integration, providing enhanced privacy, control and transparency. The reason for cutting off certain Google-related features from the web browser is a general concern about background services that communicate with Google servers. The modified Ungoogled Chromium looks very much like the regular Chromium, but its behaviour differs. The default search engine is DuckDuckGo, all pop-up windows now open as tabs, URLs aren't auto-formatted and also integration with various Google-related services has been limited. We didn't notice any feature regression or site compatibility problems but we noted better responsiveness. The ability to get rid of many statistic counters and trackers is certainly a very welcome thing.

Currently, Ungoogled Chromium is primarily offered as a source archive, which you're invited to build yourself, but pre-built binaries for Linux also exist.

Alexander Tolstoy





Windows Store » WIN PHONE

Music Cloud 10

SoundCloud repackaged.

FREE | TINYURL.COM/APC325-MCLOUD



With almost half of the total music industry's revenue in the US now coming through

subscription streaming services, for many of us, it's now become our default way of getting our tunes.

Not only is there a plethora of music streaming services that'll cater to the obvious paid market, but new offshoot apps like Music Cloud 10 are cropping-up, providing free streaming options. Music Cloud 10 draws on SoundCloud's library, so it'll only offer music that the poster owns the copyright too – which means the catalogue largely contains up-and-coming artists rather than established musical groups.

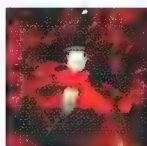
It offers 'New' and 'Top 50' music browsing lists and the ability to search for particular genres, adding up to a largely functional interface, but you do have to manually play each track and endure the constant visual advertising, so Music Cloud 10's interface certainly has room for improvement.

The genre tags on the music aren't overly useful but if you happen to like rap, hip-hop and electronic music, then there is an abundance of it to be discovered across almost all of the available genres. Joel Burgess

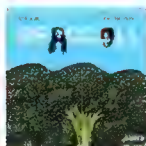
Home

Search for artists, bands, tracks, podcasts

Top Trending



21 Savage
X (feat. Future)

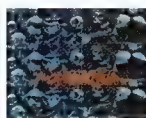


Big Baby D.R.A.M.
BROCCOLI feat. Lil Yachty



21 Savage
No Heart

New & Hot



Share Across Devices

Spread your clipboard contents.

FREE | TINYURL.COM/APC435-SHARE



The Windows 10 Anniversary Update brought a number of features to both

Windows Phone and its desktop equivalent, but one of the most 'on brand' is the addition of the Share Across Devices app. One of the most appealing features of Microsoft's Universal Windows software platform is the (theoretical) ability to transition seamlessly from working on your Windows phone to your Windows desktop. However, quickly flicking a link, password or text between two devices was more difficult than it needed to be – at least before the arrival of the new Share Across Devices app. While it's unimaginatively named and, at present, rather rudimentary in functionality, if both your phone and PC have been updated to the Windows 10 Anniversary build (14393), and you have Share Across Devices installed on each (and the apps open and running), then you can send text or hyperlinks between devices through the app. Though there are plans to add file-transfer functionality, right now this is the only app, but it's a rather clunky solution. Joel Burgess

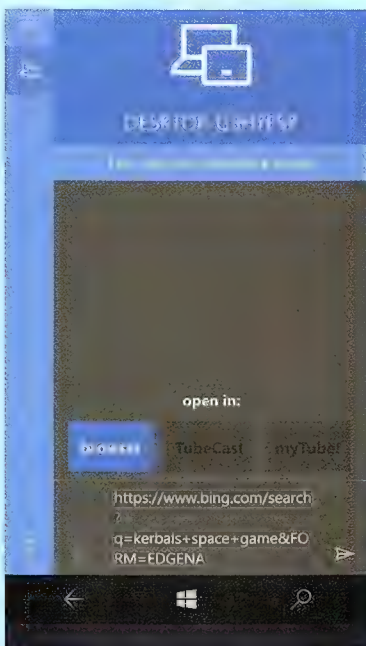


Photo Scan

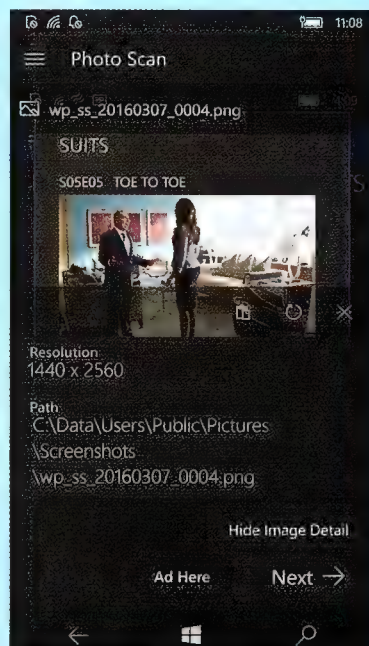
A snappy OCR scanner.

FREE | TINYURL.COM/APC435-PSCAN



If you haven't yet used a scanning application that utilises optical character recognition (OCR), then

you're missing out on a whole world of automated image-to-text tech that will totally change how valuable you find printed documents. There is no shortage of scanning apps on the Windows Store, including the leading app CamScanner, alongside Microsoft's own Office Lens, but Photo Scan manages to hold its own even against this capable competition. While the two market leaders insist on using a cropping tool before a photo can be imported, Photo Scan does it directly from the captured image. This makes importing in Photo Scan a notably faster process and if you're looking to import a full A4 page of text, then this is definitely our preferred choice. The downside is that the end result isn't quite as precise as manually cropping images to make it easier for the OCR software to translate. The number of places you can share isn't particularly extensive either, but with OneNote, Messaging and Outlook Mail integration, it'll be fine for those entrenched in Microsoft's offerings. Joel Burgess





TRUE GAMING LAPTOPS

Many doubted the day would come when laptops could finally take on desktop PCs when it came to gaming performance, but that's just what the latest generation of mobile GPUs do. Bennett Ring tests 12.

There was a time not too long ago when we would have argued against buying a gaming laptop. Big, bulky, expensive and underpowered, it usually worked out cheaper to buy a cheap work-focused laptop for getting your stuff done on the road, then buying a small gaming rig separately for playtime at home.

How times have changed, especially this year. It's now possible to buy a gaming laptop weighing just a couple of kilograms, yet delivers the gaming

performance of a dedicated gaming machine. One thing that hasn't changed, though, is price — a good gaming PC is still a rather scary proposition to your wallet.

Gaming laptops now come in three main varieties based around size — 13-, 15- and 17-inch units. The smaller machines tend to be less powerful, while the huge 17-inch slabs often come packing twin graphics cards. One thing they all tend to suffer from is a woeful battery life. When you're running hardware this fast, it churns

through batteries within a couple of hours. The other main difference between a normal laptop and a gaming laptop is the graphics processing unit — in many other ways, they're identical, with a similar CPU, amount of memory and storage. But slap a GPU into a laptop and, suddenly, it's able to process the demanding 3D graphics demanded by today's games. It's this reason they cost so much more — firstly, the GPUs aren't cheap. Secondly, they tend to run hot, so the builders have to create complex thermal solutions.

The good news is that today's gaming laptops are available in much smaller form factors, and Nvidia's new GeForce GTX 10-series mobile parts can deliver gaming performance on-par with your desktop. Just be prepared for some serious cash expenditure in the process...

HOW WE TESTED

All of the laptops in this roundup were tested identically. This began with the installation of the latest drivers of the day, Nvidia's GeForce Game Ready Driver, version 375.70, which is WHQL certified — note that not a single laptop included an AMD GPU. We then ensured the GPU driver was set to maximum power mode, single display, G-sync and V-sync disabled. We then

used 3DMark's Fire Strike benchmark, which runs at 1,920 x 1,080. While several of the laptops in this roundup supported even higher resolutions, the clear majority are only 1080p, so this was the resolution used for testing.

Next up were two real-world game benchmarks, *Grid Autosport* and *Metro: Last Light*, both at Ultra settings (though SSAA was disabled for *Metro: Last Light*). The first is known for being relatively easy-going on laptops, while the latter used to bring most laptops to a screeching halt — as you'll see, though, the latest generation of Nvidia GPUs handle it with ease.

PCMark 8 Home is used to test basic non-gaming application performance, and we ran this in the accelerated Home test. Finally, we used

CrystalDiskMark v5 to test the performance of the primary hard drive, as the main SSD can be one area where these laptops differ markedly.

We also tried to run the PCMark 8 Home Battery test, but due to the plethora of different pieces of bloatware installed on many of the machines, we found that it failed around 50% of the time. We could have removed this bloatware, but we wanted to show how each machine performed out of the box, exactly as a buyer would find it — the only reason we updated our GPU drivers is because some samples were a little older than others, and thus had older drivers.



"One thing that hasn't changed, though, is price — a good gaming PC is still a rather scary proposition to your wallet!"

Gaming laptop quick-setup guide

When it comes to making the most out of your gaming laptop, there are a few changes that can turn your machine from a chuggy, clunky brick into a blazing slab of speed. Here are our top suggestions:

1 UPDATE YOUR DRIVERS

Both AMD and Nvidia tend to release a brand new set of drivers every time a triple-A game is released. If you want the absolute best performance in your games, you simply must regularly update your graphics drivers. In fact, some games may not even work if you don't do this.

2 BLOATWARE BE GONE

One thing we've noticed with laptop makers is that some of them absolutely love to jam as much bloatware onto their machines as possible. They make a small licensing fee every time they do this, but it can really destroy the fun of gaming — slowing down your games or causing other apps to pop up. There are several ways of doing this. The slowest, but most thorough is to head to your control panel and then to the uninstall programs section, and uninstall each

piece of bloatware one at a time. There are also applications that can do this for you — the premium version of Avast Antivirus has a performance checking routine, which discovers all those apps that are sucking down your CPU cycles and disables them.

Finally, you can type "Run" into the Win10 search bar, which will bring up a command prompt. Type in "msconfig" and a control panel will load — hit the startup tab, which will take you to the Task Manager's start up area. From here you can see each and every application that loads when Windows 10 boots up — simply uncheck those that you don't want to load.

Be careful though — some of these are cryptically named and essential to the loading of Windows, so only uncheck the ones you're sure of. So do a thorough clean of your laptop when you get it, and get rid of all that junk!





go so far as to suggest noise-cancelling headphones, which will remove the fan noise entirely.

You'll also find that a touchpad might be fine for navigating Windows, but is utterly useless for pulling off 360 no-scopes in *Call of Duty*. Buy a dedicated gaming mouse to solve this. The only issue now is finding where to put your gaming mouse if you're playing whilst on the move — thankfully there are laptop lap-mounts out there that have extendable mouse pads.

"Sixty frames per second is the perfect average frame rate to maintain a nice smooth gaming experience."

GRAPHICS SETTINGS

Many of these new laptops come with G-Sync displays — ensure this is switched on. This means you'll be able to have a smooth, stutter-free experience even when the frame rates drop to around 40 or 45fps. Note that this is only supported by laptops with Nvidia GPUs, and the G-Sync adds another couple of hundreds of dollars to the price of the laptop. Also, make sure the GPU is operating at maximum power mode when the laptop is plugged in, and set to single display mode (if you're only using one monitor).

FRAME RATE LIMITING

60 frames per second is the perfect average frame rate to maintain a nice smooth gaming experience, but often your laptop will churn out even more frames than that. This means it's wasting valuable resources, such as battery life, so we suggest capping your frame rate at 60. There are several applications that have this feature, and we recommend MSI's excellent free Afterburner application for this — it'll work on any brand of gaming laptop.

OVERCLOCKING

If you're an overclocker, you might be tempted to try to crank up your CPU and GPU speeds in your new gaming laptop. However, we'd strongly advise against this... unless the maker of your laptop specifically calls it out as being overclockable. The thermal environment inside a tiny laptop is

very challenging for hardware, and pushing it past the levels the builders intended can have dire consequences. You don't want to destroy your new \$3,000 gaming laptop for a possible 10% improvement in performance.

THE DESKTOP EXPERIENCE

When you're at home and want a more traditional gaming PC experience, it's possible to use your gaming laptop as a replacement for your gaming tower. Simply hook up an exterior monitor via one of the various outputs available on your laptop — this could be HDMI, DVI-I, DisplayPort or Thunderbolt 3. Now you've got the big-screen experience, plug in a mouse and keyboard, and you've got a desktop gaming PC ready to rock and roll.

BUY HEADPHONES AND A MOUSE

It's a known fact that the speakers in most laptops are about as good as a set of \$5 earbuds from your local service station. It's a result of the challenge of having to fit speaker drivers into a chassis that is already packed to the brim with hardware, and the shallow depth of most laptops doesn't give them room for the movement that a good set of drivers requires. A good set of headphones will fix this problem entirely, with the added benefit that they'll help hide the higher fan noise that most laptops pump out compared to desktops. If your laptop happens to be a howler when it comes to fan noise, we'd even

Thunderbolt 3 brings gaming to the masses

You may not even need to buy a gaming laptop if you want to game at home. Thanks to the high speed offered by today's USB 3.0 Type-C/Thunderbolt 3 connectors, there are now external graphics card amplifiers on the market. These are basically a box with dedicated power supply and Thunderbolt 3 connection that you plug a dedicated GPU into, then plug into your laptop. Bam, you've now got the full power of that GPU, without having to buy a mobile version of it. Alienware first introduced this a year or so ago, but used a proprietary connection. Fast forward to this year and most laptops with a Thunderbolt 3 connection will support these external accelerators — Razer is the first company to release one of these, and it's called the Razer Core External Graphics Dock. At US\$499 without a graphics card, it's not exactly cheap, but it is a great way of turning your Ultrabook into a gaming powerhouse. Be aware, though, not all USB 3.0 Type-C connections support Thunderbolt 3, and not all Thunderbolt 3-equipped laptops support external GPU accelerators.



\$3,099 | WWW.ALIENWARE.COM.AU

Intel Core i7-6700HQ CPU; Nvidia GeForce GTX 1060; 15.6-inch 120Hz display; 256GB SSD and 1TB HDD

Alienware 15 R3

An entry-level GPU lets down this machine.

Alienware has released two new gaming laptops of late, and both have foregone the glitzy, neon-endowed coverings of the past. Instead, they've gone for a much more subtle, plain black look, with the anodised aluminium chassis looking just as comfortable in a business meeting as a gaming LAN. Obviously, the small alien head had to stay, though.

Our sample came with a standard 1,920 x 1,080 IPS display, though it can handle refresh rates of up to 120Hz and comes with Nvidia's G-Sync technology. To be honest, the colours and contrast were a little muted compared to some of the other offerings, but that super-fast refresh rate is perfect for gamers.

Tucked away inside our configuration was a 6th-Gen Core i7-6700HQ CPU, which seems to be the chip of choice for gaming laptops. With a Turbo speed of 3.5GHz paired with 16GB of

DDR4 memory, it's more than fast enough for the toughest games. Yet at this price point we expected much more than Nvidia's GeForce GTX 1060 Mobile, which is its entry-level mobile GPU from the latest range. As you'll see, this is rather underpowered compared to very similarly priced competitors, though the build quality of those machines doesn't compare with Alienware's exacting standards.

Due to the GeForce GTX 1060, this machine didn't exactly blaze a trail through our benchmarks. We love the sturdy design, impressive screen and mostly high-end specs, but that Nvidia GeForce GTX 1060 is a real Achilles heel at this price point.

Verdict

It's beautifully built and super slick, but at this price, the GeForce GTX 1060 just doesn't cut the mustard.



\$4,315 | WWW.ALIENWARE.COM.AU

Intel Core i7-6700HQ CPU; 16GB DDR4; 512GB SSD; 1TB HDD; Nvidia GeForce GTX 1070; 17.3-inch, 2,560 x 1,440 120Hz G-Sync display with Tobii eye tracking

Alienware 17 R3

You pay for what you get. Mostly.

Even though we put a price cap of \$3,500 on this roundup, we decided to include a couple of machines outside of that price point to see what a little extra cash would buy us. Alienware's brand new 17 R3 is one such device, and at \$4,315, we expected it to blitz the competition. And that it did – while it wasn't quite the fastest machine in the roundup, it came close.

The reason for the high price of this 17.3-inch monster is the overall build quality – Alienware's beautiful carbon fibre surface is simply beautiful to touch, and it reeks of top-notch engineering.

The display is a super-crisp 2,560 x 1,440 120Hz G-Sync panel, which is pretty-damned amazing.

It even has Tobii eye tracking, which tracks where your eyes are looking to control the camera or active windows. It sounds very cool, but in reality, we found it to be little more

than a gimmick. At this price, a GeForce GTX 1080 would have been nice (making this an almost perfect unit), but you'll have to make do with the GeForce GTX 1070 mobile.

The rest of the specs are darned impressive, though, especially the 512GB SSD and 1TB mechanical drive, delivering oodles of storage.

The i7-6700HQ with 16GB backs up the GPU, delivering overall excellent performance.

But damn it's pricey, and that's what will most likely be the deciding factor for potential buyers.

Verdict

It might not be cheap, but this machine is loaded to the brim with the best of the best.





\$2,799 | WWW.AORUS.COM
 Intel Core i7-6820HK CPU; 16GB DDR4 memory; 512GB SSD;
 Nvidia GeForce GTX 1060; 13.9-inch 1,920 x 1,080 display



\$3,299 | WWW.ASUS.COM/AU
 Intel Core i7-6700HQ CPU; 16GB DDR4 memory; Nvidia GeForce GTX 1070;
 256GB NVMe SSD; 17.3-inch 1080p 75Hz G-Sync display

Aorus X3 plus v6

The lightweight little gamer.

Who says you need to lug around a huge slab of silicon to enjoy gaming on the go these days? This 13.9-inch gamer weighs a mere 1.8kg, and will easily fit into any backpack, yet has the power to keep up with most of today's games, provided you run them at middling settings.

The steel chassis feels nice and solid, though there is a little screen flex, but we were still impressed by the crisp 1,920 x 1,080 display. While it's limited to 60Hz, it's still vivid and clear. The smaller size means the keyboard is a little cramped, and we found the touchpad keys to be a little iffy.

Despite the small size, there's a plethora of I/O ports, with a single USB 3.1 (Type-C), three USB 3.0 (Type-A), one HDMI 2.0, one Mini DisplayPort, one RJ45, and Mic-in, Earphone-out for audio. All that is impressive for such a little tacker.

Intel's 6th Generation

Intel Core i7-6820HK handles the heavy lifting up to 3.6GHz, while 16GB of DDR4 memory provides short-term storage. A 512GB SSD delivered some of the fastest read speeds in the roundup, while overall performance fell towards the bottom of the pack, strangely enough.

Gaming prowess is delivered by Nvidia's GeForce GTX 1060, which we find acceptable given the tiny size and amazing screen (smaller laptops tend to cost more due to the cost of miniaturisation).

It is a howler, though – stuffing all that hardware into such a tiny chassis means the fans have to work hard to do their job.

Verdict

If you're looking for a portable that still has the grunt for gaming, look no further than this.



ASUS G752VS

Big bodied and full of power.

At a tad under 5kg, this is an old-school behemoth of a laptop. It's huge, largely thanks to the massive 17.3-inch display, so you won't need to plug in a decent sized monitor when you get it home. It's a 75Hz model with G-Sync – just what gamers crave.

Made from aluminium and polycarbonate materials, this is part of ASUS' Republic of Gamers (RoG) range, and suitably looks the part, with bronze highlighting and glowing neon on the exterior.

The large size gives it one of the best keyboards in the roundup, and the IPS panel allows for a wide field of view.

Once again, we see Intel's 6th Gen Core i7-6700HQ wheeled out to handle CPU duties, and once again, it's with 16GB of memory, the perfect amount for today's games. Storage is extremely limited, though, with a single 256GB Samsung NVMe SSD. It's darned fast, though, posting

the top speed in our disk benchmarks. This probably helps to explain why it also did so well in our PCMark 8 Home benchmark.

Where this machine shines is the use of Nvidia's GeForce GTX 1070 Mobile GPU, which is a monster. Throw any game you like at it, and this machine will eat it alive.

The addition of G-Sync means that even if the frame rate dips to 40 frames per second, you probably won't notice.

This machine has top-of-the-line specs – the only thing letting it down is storage.

Verdict

It might be big and heavy and lack storage, but it'll devour anything you throw at it.





\$2,995 | WWW.ASUS.COM/AU

Intel Core i7-6700HQ CPU; 16GB DDR4; Nvidia GeForce GTX 1070; 256GB SSD

ASUS RoG Strix GL502VS

The 15-inch version of the G752VS.

For all intents and purposes, this appears to simply be a 15-inch version of the bigger ASUS G752VS. As a result, it's a lot more portable, only tipping the scales at a mere 2.3kg. Sure, by ultrabook standards, it's a bit of a fattie, but for a gamer, this is surprisingly light.

The screen comes with Nvidia's G-Sync technology, a nice inclusion at this price point, yet it only runs up to 60Hz, and has a native resolution of 1,920 x 1,080. It's gorgeous on the eye, though, with some of the most vivid and spectacular colours in the roundup.

We're not huge fans of the keyboard, with each key very similar in size – for example, the shift key is only slightly larger than a letter key, making it easy for your fingers to get lost in the heat of battle.

There's no surprise to see the Intel 6th Core i7-6700HQ CPU powering this machine, while the same anaemic 256GB of storage is present

as on the bigger 17-inch model. There's also the option for a 512GB SSD plus a 1TB HDD; we'd definitely pay extra for either.

16GB of DDR4 memory is plenty, and Nvidia's fantastic GeForce GTX 1070 pushes the polygons.

So basically... this machine is identical to its bigger brother, minus a slightly smaller screen and a few hundred bucks. This makes it well priced for a powerful little portable.

Verdict

Packed with top-end specs, we only wish it had a bigger hard drive and higher refresh rate on the display.



\$2,299 | WWW.GIGABYTE.COM/AU

Intel Core i7-6700HQ; 15.6-inch FHD IPS display; 16GB DDR4 memory; Nvidia GeForce GTX 1060; 128GB M.2 SATA SSD; 1TB HDD

Gigabyte P55W v6

It doesn't get much cheaper.

Okay, you can buy a gaming laptop cheaper than this, but it won't come with Nvidia's latest generation of GPU, and thus will run games like a cheap Casio calculator from the 1980s. At only \$2,299, this is as cheap as you'll get for a real gaming laptop that has the chops to be able to play today's game, not just *Solitaire* or *Candy Crush*.

It's a mid-weight model with a 15.6-inch screen, which means it's no ultraportable, with a total weight of 2.6kg including battery. But don't expect top-quality construction, with a plastic chassis. Having said that, it's thick enough to handle a little rough and tumble.

The screen is a rather standard 15.6-inch 1,920 x 1,080 IPS panel, and like all of the laptops in this roundup, we appreciate the matte finish, which means it won't turn into a mirror in bright lighting conditions.

Surprisingly, Gigabyte has included both a 128GB SSD

for your OS, as well as a 1TB mechanical drive for your less important files. There's even an optical drive, a rarity these days.

Sure, 128GB isn't much, but at least there's the backup drive for more storage.

We're sure you can guess which CPU this machine uses – the ubiquitous 6th Generation Intel Core i7-6700HQ paired with the usual 16GB of DDR4. At this price, the GeForce GTX 1060 is to be expected – it'll run your games fairly well, but as our benchmarks show, a gaming monster this machine is not.

Don't even bother looking for anything cheaper than this if you want a decent gaming machine.

Verdict

Gigabyte has managed to cram in plenty of goodies into this machine on such a tight budget.





\$3,699 | WWW.HP.COM/AU

Intel Core i7-6700HQ; 16GB DDR4; Nvidia GeForce GTX 1070; 17.3-inch 1,920 x 1,080 display; G-Sync

HP Omen 17-w106TX

Appropriately named.

The new Omen (we assume it was named for its devilishly good looks...!) from HP only just fell outside of our price point, so it wouldn't be fair not to include it. It's black and red colour scheme is both subtle yet a little bit evil, making it a sexy attraction for those with a dark side.

Considering the price, HP has managed to cram in a decent amount of goodies. It's a big 17.3-incher, with a 1,920 x 1,080 native resolution, and though there is G-Sync support there's no fancy high refresh rate here.

One highlight are the surprisingly clear Bang & Olufsen quad speakers – we're used to horrible laptop sound, but in this regard, the Omen actually delivers audio that you won't mind listening to.

The 128GB SSD is rather sparse to say the least, but it's backed up by a huge 2TB mechanical drive. Despite the large size, there aren't a lot of I/O options, with

twin USB 3.0, one USB 2.0, mini-DisplayPort and a HDMI output. It's strange to see a brand new laptop without a single USB 3.0 Type-C connection, which is one of this year's key new technologies.

Gaming grunt comes courtesy of a GeForce GTX 1070 mobile, 16GB of DDR4 and – yup, you guessed it – Intel's i7-6700HQ.

As you can see from our benchmarks, this is more than enough to power through today's games.

In all, this machine isn't outlandishly priced – at only a couple of hundred dollars more than competing machines.

Verdict

HP has delivered a very attractive gaming machine, though it does lack in I/O options.



\$2,449 | WWW.METABOX.COM.AU

Intel Core i7-6700HQ CPU; 16GB DDR4; 275GB SATA 3 SSD; Nvidia GeForce GTX 1070

Metabox P670RS-G

An utter steal of a machine.

The Gigabyte back over the page was just \$150 cheaper than this machine, yet it had a far inferior GPU. While the Gigabyte uses the GeForce GTX 1060 mobile, the Metabox P670RS-G comes with the much faster GeForce GTX 1070 mobile. This is at least 30–40% faster than the GeForce GTX 1060 mobile, giving the Metabox the potential to be a far faster gaming machine.

Yet our benchmarks initially showed this machine to be the slowest of the lot. It turns out that there's a piece of software tucked away that has to be used to disable the integrated GPU for the machine to work properly. It's not easy to see, and meant we had to spend hours figuring out just what the heck is going on. When we spoke to Metabox, they explained it had something to do with the choice of CPU, but no other laptop in the roundup required any such software to function

correctly. We'd highly suggest Metabox makes this feature far more prominent, as it's currently incredibly easy to overlook.

Once we did get this 17.3-inch machine working properly, it proved to kick some serious butt. The combination of the i7-6700HQ CPU, 16GB of memory and GeForce GTX 1070 saw it hitting near the top of our scores. It even has G-Sync, though the maximum refresh rate is only 60Hz.

This machine represents unparalleled value – top performance, G-Sync and a whopping bit 17.3-inch screen for just \$2,500.

Verdict

Simply amazing... once you find that annoying GPU setting.





\$3,356 | WWW.METABOX.COM.AU

Intel Core i7-6700K CPU; 16GB DDR4 memory; Nvidia GeForce GTX 1070; 275GB SATA 3 SSD; 17.3-inch 120Hz display with G-Sync

Metabox P775DM2

High performance, high price.

Unlike its troublesome little brother (opposite), the P774DM2

didn't give us any weird performance issues, as it didn't have the special toggle software that switches between the discrete or integrated GPU: which is a plus in itself. What did surprise us, though, was its overall performance – considering it's packing a GeForce GTX 1060 mobile, we didn't expect it to score so well against GeForce GTX 1070-powered machines.

This is a much larger machine than its brethren, as it's based around a 17.3-inch display. It's a vastly superior screen to most all of the rest in the roundup, as it has a huge 120Hz refresh rate, along with G-Sync. It's also 2,560 x 1,440, delivering one of the crispest images of the lot.

We also have to hand it to Metabox for their intelligent keyboard designs, which mimic desktop keyboards closely,

making it super easy to get used to.

One of the key reasons for this machine's high performance results is the use of a desktop processor, the Intel 6th Generation i7-6700K, which has a Turbo speed of 4.2GHz.

As usual, 16GB of DDR4 memory is included, which appears to be the defacto standard in this price range. Storage is a little lacking, though, with just a single 275GB SATA 3 drive.

We're a little surprised at the high price considering the use of a GeForce GTX 1060 mobile, but that's the price to be paid for such a beautiful screen.

Verdict

The display is an absolute killer, with a super fast refresh rate and G-Sync, plus that desktop CPU...



\$2,499 | AU.MSI.COM

Intel's Core i7-6700HQ; 16GB DDR4; 256GB SSD; 1TB HDD; Nvidia GeForce GTX 1060; 17.3-inch 1,920 x 1,080 display

MSI GE72VR 6RF Apache Pro

Another brute of a gamer.

MSI has one of the largest range of gaming laptops on the market, covering every segment you can think of. The MSI GE72VR 6RF Apache Pro fills its affordable 17.3-inch space, and it's fantastic value for money. Obviously, it's not designed for gamers who want to be able to carry it around all day, as it weighs in at 2.7kg, but if you're looking for a machine that is destined to spend most of its life on a desk, this is one of our favourites.

The screen resolution of 1,920 x 1,080 might seem a little low for such a huge screen, yet we couldn't spot any pixels. It's an IPS panel, allowing for wide viewing angles, and beautiful colour and contrast.

Due to the large size, we expected a plethora of I/O options, so were surprised to see relatively few. Along with a single USB 3.0 Type-C connection, there's only two USB 3.0 Type-A connectors, compared to the three of the

smaller machine (over the page). There's also a single USB 2.0 connection. The inclusion of an optical drive is handy, though in this day and age of digital distribution, we can't help but feel it's a tad obsolete.

Tucked away inside is the gaming CPU of choice, Intel's 6th Generation Core i7-6700HQ, and again, we see the popular choice of 16GB of memory. Two hard drives are included; a single 256GB NVMe SSD, along with a 1TB mechanical hard drive. The choice of Nvidia's GeForce GTX 1060 is the only let-down – you're paying extra for the bigger screen, rather than a more powerful GPU.

Verdict

This is a traditional gaming brute, big, bold and heavy.





\$2,799 | AU.MSI.COM
Intel Core i7-6700HQ; 16GB DDR4 memory; Nvidia GeForce GTX 1060;
128GB SSD; 1TB mechanical hard drive

MSI GS63VR 6RF Stealth Pro

Welcome to tiny-town.

Where the GE72VR (back over the page) is MSI's offering for those who demand a big-screen machine, the GS63VR 6RF Stealth Pro targets those who are after something a little more portable.

Built around a 15.6-inch display, it's definitely the more mobile of the two, and only weighs 1.8kg compared to the 2.7kg of its bigger brother. Yet, despite its smaller size, it actually (bafflingly) has more I/O options, with one USB 3.0 Type-C, three USB 3.0 Type-A and a single USB 2.0. There's no optical drive this time around, though, which makes more sense in this day and age.

The display uses the standard HD resolution of 1,920 x 1,080, with an IPS panel delivering all of the benefits of this type of display.

We have to point out that this was one of the better panels in the roundup, offering richer colours and

better contrast than the majority.

Storage is a little lighter this time, however, with a smaller 128GB SSD alongside the 1TB mechanical hard drive, which will fill up in no time.

You'll probably have noticed a general trend with laptop specs around this price, and this laptop is no exception. The usual i7-6700HQ with 16GB of memory and GeForce GTX 1060 combine to deliver solid gaming performance, but you're paying considerably more for it in this form factor than the likes of the Metabox.

Verdict

Specs are standard for a 15.6-inch laptop, the price is just a tad high when compared to others.



\$3,493 | WWW.ORIGINPC.COM.AU
Intel Core i7-6700HQ; 16GB DDR4; 240GB SSD; Nvidia GeForce GTX 1070;
15.6-inch display

Origin PC EON15-X

Full speed ahead thanks to a factory overclock.

While most of the laptops included in this roundup featured some kind of control centre software, where the laptop could be set to 'performance', 'gaming', 'quiet' and certain other modes, the EON15-X comes out of the box with all of the overclocking modes already done. This is why it performed so darned well in testing, outshining other machines with similar specs.

There's a price to be paid for this, though (but, of course, there is), with the highest fan noise of the lot. As you can see, it roared to a maximum volume of 58dB during our Metro: Last Light testing session, by far the loudest of the lot.

A pair of noise-cancelling headphones will be a must with this machine, as even with normal headphones, we think it'd be possible to hear the fans over your game.

This 15.6-inch laptop crams in some top-end

hardware to help it reach the top of the pile. Origin has gone for the desktop i7-6700K instead of the mobile i7-6700HQ, and it has a 700MHz benefit over the other chip, with a Turbo speed of 4.2GHz. A GeForce GTX 1070 mobile is also included, and it, too, has been overclocked out of the box. 16GB of DDR4 memory is the norm, while a single 240GB M.2 SSD is the only storage – we highly suggest upgrading this at the time of purchase.

Considering all this, it is a bit pricey and, yes, it's also quite loud, but the sheer performance you'll get out of this little machine makes it our top option for portable gaming goodness.

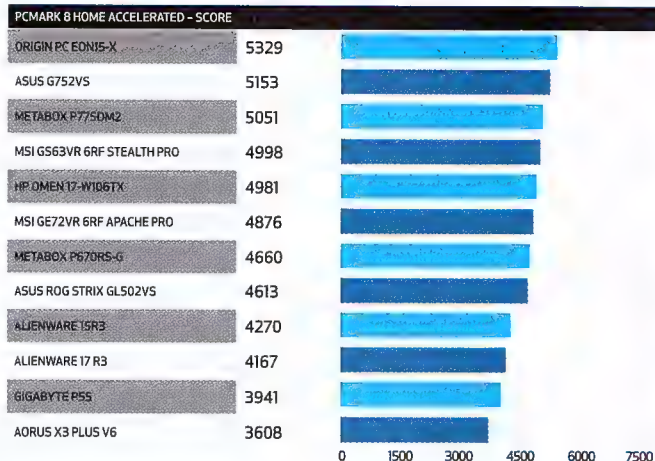
Verdict

It might be loud, but this thing is the clear winner.

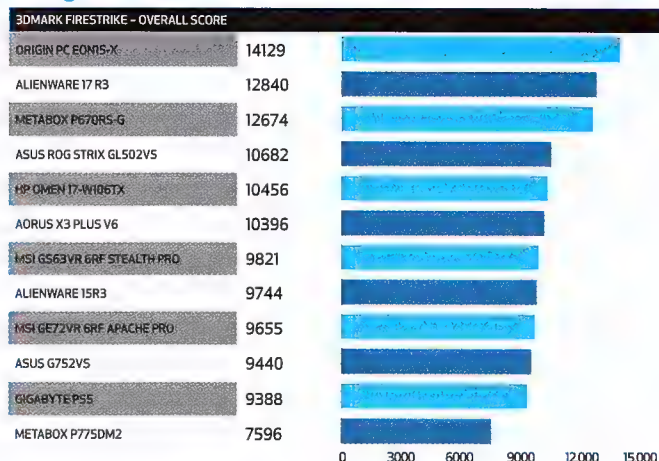


LABS BENCHMARK RESULTS

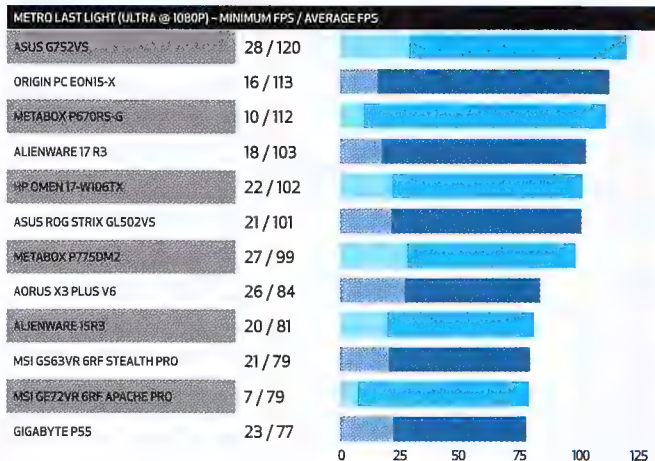
General System Performance



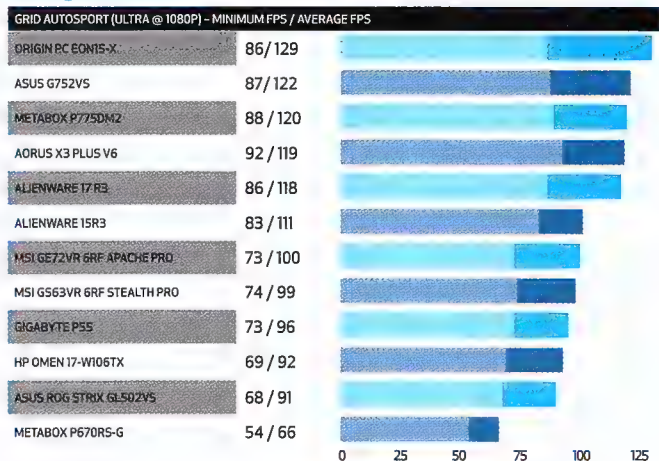
Gaming Performance



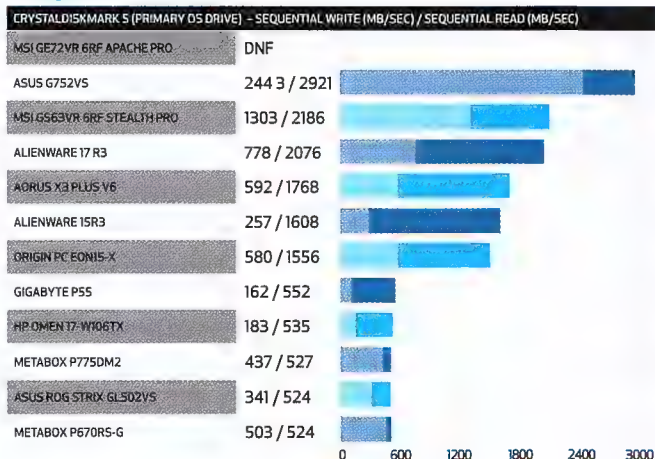
Gaming Performance



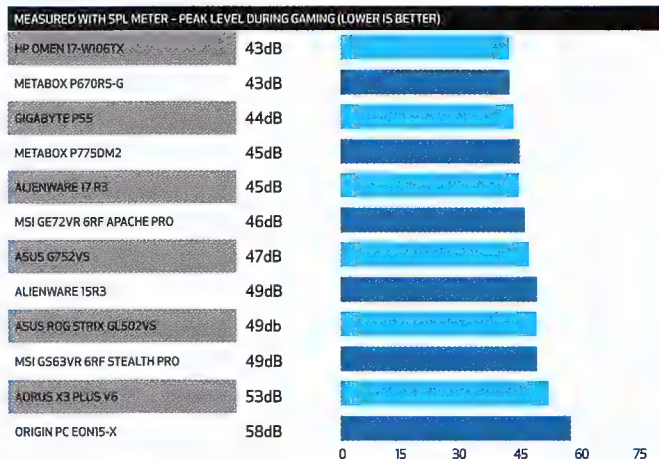
Gaming Performance



Storage Performance



Acoustics





PRODUCTS OF THE YEAR

**THE APC TEAM SELECTS 2016's BEST PCs,
PERIPHERALS, GADGETS & GEAR!**

With the plethora of computing products that are released every year, narrowing it down to just our favourite 60 products — as we've done in this Products of the Year feature — was quite a challenge. And of course, with tech having expanded into so many different parts of our lives, the recommendations in this awards feature come not just from the pages of *APC*, but also our sister print publication *TechLife* alongside two of our online siblings, *TechRadar* and *PC Gamer*. We reckon it'll serve as a great starting point for Christmas gift ideas — even for the PC enthusiast with 'everything', there's bound to be a device or two in here that are, at the very least, a worthy upgrade from something that's getting a little long in the tooth.

TABLETS & 2-IN-1S



Apple iPad Pro 9.7-inch

FROM \$848 • WWW.APPLE.COM/AU

The iPad Pro 9.7 looks, sounds and performs better than the iPad Air 2. Its colour-rich display impresses, its four speakers drown out the audio of other tablets and the faster specs keep this tablet running smoothly. Even the 12MP camera is impressive. Apple is slowly transforming its iPad into a 2-in-1, and while this new tablet may not be a laptop replacement, it's more than simply an iPad Air 3. And it's now the ideal size, pushing aside the 12.9-inch that's frankly a little too big for most tasks.



Microsoft Surface Pro 4

FROM \$1,499 • WWW.MICROSOFTSTORE.COM

The slimmer form factor, better display and the chances to the Type Cover keyboard have done wonders for the Surface Pro 4. Microsoft seems to have captured and applied the best definition of 'iteration' to almost every end of the tablet, making it well worth the wait for creative professionals, students and everyday folks alike. But is this finally the tablet to replace your laptop? That's still debatable, though the Pro 4 has surmounted more of what's running against it than ever before.



Samsung Galaxy Tab S2 9.7

\$569 • WWW.SAMSUNG.COM/AU

There are plenty of reasons to invest in the Galaxy Tab S2, especially if you're after the best Android tablet on the market. It's reading and web surfing-friendly, while the new 4:3 screen and general size and shape is better suited for most tasks. The TouchWiz software doesn't get in the way of Android 5.1.1 too much, and it includes a fingerprint sensor in the home button and solid build quality. It's not as powerful or as long lasting as it could be, but it's enough for a consumer tablet.



Apple iPad mini 3 (refurbished)

\$369 • WWW.APPLE.COM/AU

Apple offers both the iPad mini 2 and mini 4 on its regular shopfront, but our tip is to use the company's official refurbished store and get a mini 3 instead — it's only \$10 more than a new mini 2, and offers significantly faster hardware. That means it'll last longer and receive more major updates to iOS and because it's Apple that's refurbished the unit, it has a new battery and outer-shell — and still comes with an official one-year warranty too.



HP Spectre x360 13-W012TU

\$2,398 • WWW.HP.COM/AU

The new HP Spectre x360 is better in every way. It has a slimmer, more premium design, it's faster and it's one of the longest-lasting machines we've ever tested. It has a new micro edge display that makes it brighter and intensifies colours. This is also a speedy machine, for everything from starting programs, to loading up a dozen websites simultaneously, to headier tasks like video editing. If you're in the market for something with higher-end specs, then this option is great value.



Lenovo Yoga 710 (11-inch or 14-inch)

FROM \$849 • WWW.LENOVO.COM/AU

The Lenovo Yoga 710 is one of the high points in this new tablet/laptop era, with a super-flexi hinge for a bit of hybrid flavour. Build quality, screen and keyboard are good, and battery life is excellent. Other than an occasionally fiddly-feeling trackpad and lack of memory card slot, you'll only encounter issues if you radically overestimate what an Intel Core M device like this can do. Available in 11-inch and 14-inch versions, consider which size best suits your needs and go with that.

LAPTOPS



**BEST
ULTRABOOK**

Dell XPS 13 (2016)

FROM \$1,999 • WWW.DELL.COM

With this late-2016 update to the XPS 13, Dell hasn't messed with what ain't broke — we've got updated internals and a new colour option, that's it. Dell's idea of 'rose' is a nice, subdued reddish-orange hue. Intel's new Kaby Lake processor has jumped up battery life on the model we tested. This is still a top-notch ultrabook, with a fantastic keyboard and trackpad and tough build quality. And the other bit of good news is that the chassis still comes in silver too.



**BEST GAMING
LAPTOP**

Gigabyte P57X v6

\$2,800 • WWW.GIGABYTE.COM.AU

Nvidia's latest 10-series GPUs have really kicked laptop gaming into another gear entirely, providing near-desktop PC performance that you can take anywhere. With a GTX 1070, this 17-inch Gigabyte machine is one of the least-expensive ways to get on board and, boy, does it fly when it comes to gaming. This was the first GTX 10-series laptop we tested, but it managed to stand up to the best of those in this month's round up.



**BEST BUDGET
LAPTOP**

Acer Aspire ES1-431-P2SZ

\$430 • WWW.ACER.COM.AU

It won't win any speed awards, but if you just need a solid all-rounder laptop without the frills, the Aspire ES1-431 delivers just that — and won't break the bank. At this \$430 price, you get a 14-inch screen at 1,366 x 768 pixels, Celeron processor, 4GB of RAM and 500GB hard drive. That'll handle day-to-day computing tasks with ease — just don't expect to do anything high-end, like high-def video editing or gaming. A good-value buy.



**BEST
CHROMEBOOK**

Dell Chromebook 11 3120

\$466 • WWW.DELL.COM.AU

Dell's packed in features that are typically reserved for more expensive business notebooks into its Chromebook 11 in an effort to create a durable product for the education market. In the Chromebook 11, you'll find a 180-degree reinforced hinge, rugged design, sealed keyboard and trackpad, and a great typing experience inside a portable package. In addition to using the Chromebook for school, students will appreciate the loud stereo speakers for multimedia and entertainment.

PC COMPONENTS



**BEST
DESKTOP CPU**

Intel Core i5-6600K

\$330 • WWW.INTEL.COM

Building a PC to handle heavier loads is where Intel's Core i5 line excels, nowhere more so than in their unlocked enthusiast part, the Core i5-6600K. With a really good graphics card, this processor handles even the most demanding games and is capable of a steady (and stable) overclocking to 4.6GHz. And depending on the motherboard, it's very easy to bring more PCIe lanes and new technologies into the fray.



**BEST
MAINSTREAM GPU**

AMD Radeon RX 470

\$320 • WWW.AMD.COM

AMD's appealing all-rounder comes in at a competitive price point, making the Radeon RX 470 pretty much untouchable. A slightly cut-down version of the RX 480, the 470's clock speeds top at 1,206MHz, with 4GB of onboard GDDR5 memory. It's a comfortable 1080p/Ultra card, clearing most modern games at 70fps, and can even stretch to 1440p in many titles at Medium details. On a frames-per-dollar metric, the RX 470 ranks high, making this one top-value offering.



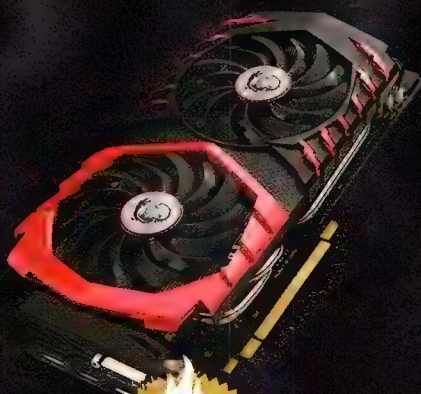
BEST BUDGET
DESKTOP CPU

Intel Core i3-6100

\$160 • WWW.INTEL.COM

Despite being only a dual-core, Intel's i3-6100 isn't noticeably slower than the i5-6600K when it comes to gaming, as the enabled Hyper-Threading gives you two logical cores to add to the physical cores. Turbo Boost is also disabled, so the chip runs at a stead 3.7GHz under load.

Depending on your graphics card, even the i3-6100 might prove more than enough for your gaming needs. For a low-cost PC build, the i3-6100 offers a great answer.

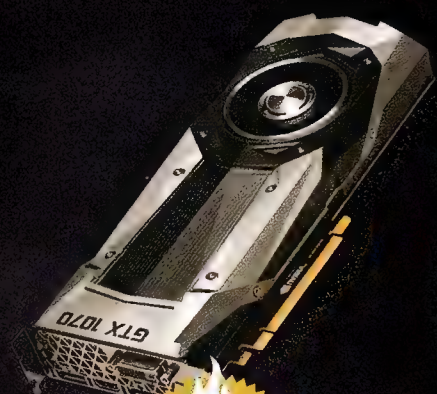


BEST EXTREME
GPU

Nvidia GeForce GTX 1080

\$959 • WWW.NVIDIA.COM

If money is no object, you really can't go wrong with the GeForce GTX 1080. A single overclocked GTX 1080 can net you a 60fps average on most games, even if you're gaming at 4K or on a larger ultrawide. While a pair of GTX 1070s in SLI will cost around this price, the latter requires some degree of troubleshooting and doesn't work with all games. The GTX 1080 is the safer, simpler bet, and one we recommend for most setups.



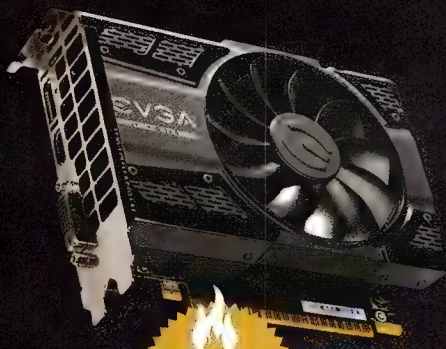
BEST
PREMIUM GPU

Nvidia GeForce GTX 1070

\$625 • WWW.NVIDIA.COM

If you want high frame rates or 4K gaming on a budget, this is the most economical option you'll find.

The GeForce GTX 1070 will very comfortably give you 1440p/Ultra gaming on a higher-res monitor at Medium detail settings and is the card you'll need if you're buying a new 32-inch ultrawide display. The GTX 1070 is faster than its predecessor, has an ample 8GB of memory and proves to be an impressive overclocker as well.

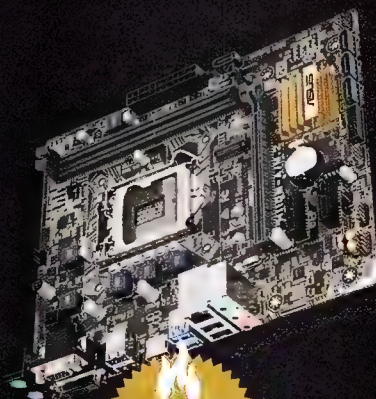


BEST BUDGET
GPU

Nvidia GeForce GTX 1050 Ti

\$245 • WWW.NVIDIA.COM

If you're a budget gamer, then all you require is a card that can average 60fps at 1080p in modern games, and the GeForce GTX 1050 Ti delivers that for a pretty good price. The GTX 1050 Ti and the lower-end GTX 1050 outperform AMD's competing cards by quite a considerable margin. For a cost of less than \$250, the GTX 1050 Ti is great value on an FPS-per-dollar scale.

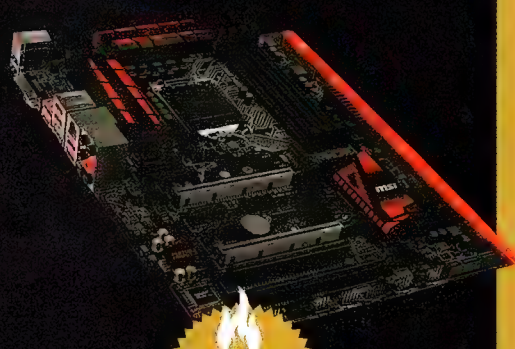


BEST BUDGET
MOTHERBOARD

ASUS H110M-A/M.2

\$95 • WWW.ASUS.COM/AU

Intel's H110 chipset is Skylake at its most minimal – but it still gives you a platform that's more than capable of powering a basic all-rounder PC. This ASUS model is one of the most popular (the non-M.2 version even moreso). This board provides a good mix of essential features from a big-name brand at a nice competitive price. The main thing you're missing out on is high-end expandability – you get fewer expansion slots for storage, memory and PCIe devices.



BEST MIDRANGE
MOTHERBOARD

MSI Z170A Gaming Pro

\$260 • AU.MSI.COM

The Z170A Gaming Pro delivers an experience well beyond the modest asking price, with full-speed M.2, heaps of USB ports and enhanced ALC1150 audio. Memory support tops off at 3,600MHz and Intel Gigabit LAN is provided for wired network connectivity, along with protection circuitry to prevent voltage spikes. MSI's BIOS doesn't offer the deep granularity found elsewhere but does remain one of the easiest to use, and overclocking doesn't seem to suffer much from this.

PC COMPONENTS



BEST EXTREME
MOTHERBOARD

2016

ASRock X99 Taichi

\$365 • WWW.ASROCK.COM

ASRock has produced the X99 Taichi for a relatively cheap price — cutting back on the USB ports and the sound (although that isn't noticeable) — but in terms of performance, it's in par with its more expensive Gaming i7 sibling. The rest of the Taichi is top-notch, with three PCIe x 16 slots that handle SLI and CrossFireX, as well as support for up to 128GB of 3300MHz RAM. You also get dual M.2 slots, dual Gigabit LAN and dual-band 802.11ac Wi-Fi.



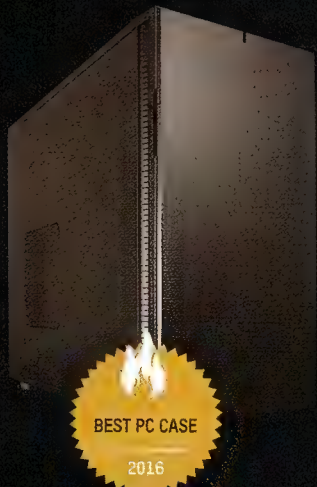
BEST MINI-ITX
MOTHERBOARD

2016

Gigabyte Z170N-Gaming 5

\$250 • WWW.GIGABYTE.COM.AU

At the heart of the Gaming 5 is the Intel Z170 chipset, which supports the latest socket LGA 1151 CPUs. You can plug in up to 32GB of dual channel 3,333MHz RAM. It also has a PCIe 3.0 x 16 slot for a GPU, 4K-compatible HDMI and DVI outputs, an M.2 x 4 port and has room for full-length 2280 drives. Along with the USB ports, it has Gigabit LAN via a Killer E2201 chip, as well as an 802.11ac Wi-Fi card with Bluetooth 4.2. The board's also well laid out and gives solid performance.



BEST PC CASE

2016

Fractal Design Define R5

\$170 • WWW.FRACTAL-DESIGN.COM

The Design Define R5 was released in 2015, but it's still Fractal's current flagship model, and it's a helluva good-value PC case. It's ideal for building an ATX system that doesn't need extensive cooling or multiple graphics cards. The metal used throughout is smart and minimal, and its side panels are coated with sound-absorbing material. The hard disk cage is full of solid metal caddies, and it's removable in two stages, plus it supports water-cooling hardware.



BEST MINI-ITX PC
CASE

2016

NZXT Manta

\$195 • WWW.NZXT.COM

The NZXT Manta has excellent build quality and the matte finish gives the case a stealthy look. The vertical channel and the rear side panel allows for good cable management, as the doors don't lie flat against the chassis. There are cooling options for double-wide radiators up top and up front, so you can water-cool that GPU if you're so inclined. On top of all this, you can use full-size video cards in this compact case without worry.

NETWORKING



BEST ROUTER

2016

ASUS RT-AC88U

\$419 • WWW.ASUS.COM/AU

With the RT-AC88U, speed isn't the only thing ASUS has thrown into the mix. There's also four extra Gigabit Ethernet ports in the back, for a total of eight, and a sprinkling of upgrades and additions to the router OS. ASUS has also upgraded its Quality of Services tool, and that's on top of an already overflowing range of excellent features for parental filtering, bandwidth monitoring, basic NAS features, VPN server and client support.



BEST WIRELESS
EXTENDER

2016

ASUS RP-AC68U

\$229 • WWW.ASUS.COM/AU

It's not small or discrete (or cheap), but this wireless extender is so amazingly feature-packed it's hard not to be impressed. It's AC1900 Wi-Fi with four MIMO antennae and has built-in LEDs which can help you figure out the best position by indicating signal strength. It has five Gigabit Ethernet ports and you can even add in a USB hard drive and have it serve as a NAS. Plus, you can switch it into bridge mode, if desired.



Edimax BR-6478AC V2
\$79 • WWW.EDIMAX.COM

The Edimax BR-6478AC V2 blitzes its cheaper competition with Gigabit Ethernet and Wi-Fi speeds of up to 867Mbps at an affordable price. Sporting two antennae handling 2.4GHz and 5GHz bands, the router has four LAN ports along with a Gigabit WAN connection. While it can't handle an ADSL connection, it's ready to connect to the NBN. And the range is excellent. The BR-6478AC V2 also has a single USB 2.0 port, which can be connected to a printer or portable storage device.



ASUS DSL-AC68U
\$309 • WWW.ASUS.COM/AU

ASUSWRT remains the best consumer firmware around. It supports VPN connections natively and its traffic management and QoS features are better than the rest. It supports the use of 3G/4G USB modems as a failover or primary internet access tool, lets you access connected storage devices remotely and has user-level parental controls and access restrictions. It's all you could ask for. The ASUS DSL-AC68U might be one of the older products on this list, but there's enough horsepower here for most homes.



D-Link DSL-2750U
\$45 • WWW.DLINK.COM.AU

Plain, white and affordable, the D-Link DSL-2750U ticks all the boxes for a basic but functional Wi-Fi router. It has a maximum speed of 300Mbps and sports four LAN ports. It has an ADSL2+ model built in, and includes both a telephone cable and ADSL splitter/filter. Wireless range is quite good and gave consistent coverage over our test house. D-Link has also included a USB 2.0 port, and the web interface and easy setup are top-notch.



TP-Link TL-PA8010P
\$125 • WWW.TP-LINK.COM.AU

Supporting the latest HomePlug AV2 spec, the TL-PA8010P uses 2x2 MIMO tech and all three power wires to offer speeds of up to 1,200Mbps. In real-world testing, the adaptors managed 221Mbps up and 219Mbps down – faster than any other PowerLine device tested. The system can handle longer ranges better and make a connection in places that lesser devices won't be able to reach. Installation is easy – plug them in and hit the button. While it's pricey, it's well worth the extra cost.



Edimax HP-5102Wn
\$65 PER UNIT • WWW.EDIMAX.COM

Edimax takes a different approach with its powerline adapters, often selling them as single units rather than in pairs. That's actually a good thing in our book, as it lets you mix and match to meet your specific networking needs. This adapter offers standard Fast Ethernet over powerline – so you can plug in a wired device at the other end of the house – but also throws in an 802.11n Wi-Fi access point, so you get wireless extension too.



ASUS EA-AC87
\$219 • WWW.ASUS.COM/AU

The EA-AC87 can create a wireless link at speeds of up to 1,734Mbps and it doesn't need a compatible 4x4 Wi-Fi router. It has a five-port Gigabit switch built in and can also be used as a Wi-Fi access point. The media bridge has an LED readout that shows the link quality. The EA-AC87 is fairly expensive, but it's miles ahead of most wireless connections and more than enough for fast file transfers or multiple HD streams.

PC PERIPHERALS



BEST GAMING MONITOR

ASUS RoG Swift PG348Q

\$1,779 • WWW.ASUS.COM/AU

The ASUS PG348Q is a 34-inch monster with a 3,440 x 1,440 resolution and a 21:9 aspect ratio. The panel itself is IPS, with a 0.2325mm pixel pitch, 5ms GTG response time and the ability to display 10-bit colour. The LCD is compatible with Nvidia's G-Sync and offers a 100Hz refresh rate. The OSD is good, with various gaming modes and other options. It's the pinnacle of gaming PC screens – a gorgeous monitor – despite its eye-watering price.



BEST PROFESSIONAL MONITOR

Dell UltraSharp U2717D

\$849 • WWW.DELL.COM

This successor to the U2715H doesn't massively improve on its forebear, but then it doesn't really need to – it's a great pro-oriented screen that strikes a pleasing balance between affordability and performance. For \$850, you get a 27-inch, 1440p PLS panel (made by Samsung) that's factory calibrated for sRGB colour coverage. Its lag is a little higher than we'd like for gaming, but then this is a screen more aimed at budding photo and video editors and others who need colour-accurate visuals.



BEST BUDGET MONITOR

ViewSonic VX2457-mhd

\$169 • WWW.VIEWSONIC.COM/AU

This 24-inch widescreen display takes a 'Why not both?' approach and gives you a low-cost monitor that's great for gaming. The VX2457-mhd boasts a super-fast 1ms response time, but the standout feature is the 75Hz refresh rate, along with FreeSync support. The matte display offers strong colours and good image quality. It has the usual ports, a pair of speakers and a stand with basic tilt adjustments. For just another \$80, you could upgrade to the larger 27-inch version.



BEST LAPTOP MOUSE

Logitech MX Anywhere 2

\$80 • WWW.LOGITECH.COM

This robust little mouse from Logitech is decidedly geared towards mobile use. It's wireless with a long-lasting Lithium-ion internal battery (that charges via microUSB cable) has a sensor that tracks on just about any surface, and it's not too tall, so it slips in bag side-pockets easily. The wheel can be flicked between ratcheted and free-spinning too – a nice little customisation option. We do wish it included a carry-bag though, to help keep it dust-free.



BEST PRINTER (BUDGET)

Canon Pixma MG2960

\$49 • WWW.CANON.COM/AU

The Canon PIXMA MG2960 inkjet can print, scan and copy in colour, plus send B&W faxes. It has USB and Wi-Fi that supports the PIXMA printing app, Apple AirPrint and Google Cloud Print. The unit boasts a 4,800 x 1,200dpi resolution, and can handle up to 100 sheets and prints at 8.8ipm B&W, and 4.4ipm in colour. Perfect for documents, but only okay for photos. The scanner has autofeed functionality and can make copies of up to 99 pages in one batch.



BEST PRINTER (MIDRANGE)

Epson WorkForce WF-3620

\$189 • WWW.EPSON.COM/AU

The Epson WF-3620 prints, copies, scans and faxes, in both colour and B&W. It has inbuilt Wi-Fi and an Ethernet connection. The inkjet printer has a max 4,800 x 2,400dpi, and is rated at 19ipm for plain black text, and 10ipm for colour. It can print and scan on both sides of a page. The scanner handles up to A4 and captures 48-bit colour at 2,400 x 1,200dpi. Quality is excellent, and a noticeable step up from lower-resolution models.



Logitech C920

\$120 • WWW.LOGITECH.COM

The C920 is not new – and its replacement is releasing soon – but this is still our pick because all you have to do is look at its picture quality. It shoots 1080p video with a large FOV, a sharp image and a wide angle making everything about its picture look more ‘camera’ than ‘webcam’. Its auto image adjustments are great even in low light. Its focus, white balance and brightness are impeccable, making it our top choice for live-streaming games.



ASUS Strix Tactic Pro

\$115 • WWW.ASUS.COM/AU

The ASUS Strix Tactic Pro gaming keyboard comes with a plethora of extras, including 21 macro keys that have the ability to record different functions on different profiles – with a bank of eight on the left, another three under the spacebar and the remaining double as regular keys. It also includes swappable bright orange WASD keys, a multimedia control pad above the regular numpad and four different Cherry switch options. This beast has it all.



Razer DeathAdder Elite

\$120 • WWW.RAZERZONE.COM

We’ve done a full review of the DeathAdder Elite on page 35 of this issue, but to summarise, Razer’s latest update to its crowd-favourite gaming mouse is the best iteration yet, maintaining the ergonomic shape but swapping the sensor for a new higher-DPI type that fractionally improves performance over its Chroma predecessor. That said, the Elite is expensive for what is a relatively basic pointer – so we’d argue the \$80 Chroma still offers the best overall bang for buck.



HyperX Cloud Revolver

\$130 • WWW.HYPERXGAMING.COM

The Revolver headphones are monstrously good value for money. With an incredibly wide soundscape, great comfort and options for both 3.5mm and USB connections, you’d be hard pushed to find anything better for the price. The design is open-backed with a removable mic, and perform well playing music as well as in-game noise. They do have a gaming flair about the design, which might not cater to all tastes, but they’re super comfortable.



Razer Ripsaw

\$240 • WWW.RAZERZONE.COM

The Razer Ripsaw is one of the few capture devices targeted at providing a solution for the gamer looking to record from anything to everything. You can plug the Ripsaw in and play straight from one rig into another. And it’s fairly painless to set up. Our testing found the Ripsaw wonderfully consistent, with recordings crisp and sharp. Despite not having the option of capturing footage above 1080p, using the Ripsaw makes for a surprisingly enjoyable experience.

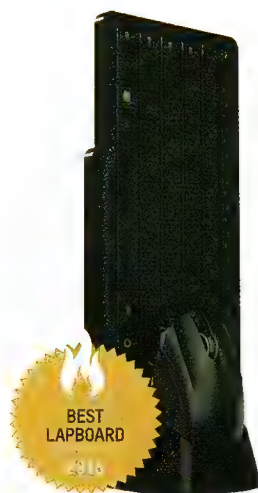


HTC Vive

\$1,399 • WWW.VIVE.COM

Although an expensive option, HTC’s full kit gives you everything you need to control and move around in real, and virtual, space. The Vive’s room-scale abilities really make it shine. It allows you to roam in real 3D space and the controllers allow for precise movement and are comfortable to use. And the good news is that the HTC Vive will finally be available at Australian retailers for \$1,399 by the time this issue hits the stands.

PC PERIPHERALS



Razer Turret
\$219 • WWW.RAZERZONE.COM

This wireless Bluetooth lapboard-and-mouse deck is aimed at living room PC gamers and it's gone for a sleeker design than most of its peers. The small mousepad is magnetised, meaning the included mouse is easy to keep grounded, and the pad bends back on hinges to reveal the charging port – charging is effortless. Its design means it can easily be used for activities outside gaming. The only downside is that its keys lack backlighting, which can be problematic in dark gaming dens.



Sony PlayStation DualShock 4
\$99 • WWW.PLAYSTATION.COM

This might be a controversial choice, but stay with us: we have some good reasons. The DS4 may not look very sturdy, but it's durable. Put as much force as you can on the controls and they just spring back as if nothing happened. They have a more tactile feel and cause a lot less strain as compared to the Xbox controllers. We also find the analog sticks to be slightly better than Xbox One's. The DS4 may not be intended for PC, but it's our favourite controller anyway.



Alienware Graphics Amplifier
\$199 • WWW.ALIENWARE.COM.AU

This surprisingly affordable add-on can seriously rev up a compatible Alienware laptop or Alpha. While it only works in conjunction with Alienware systems, the Graphic Amplifier is still an impressive bit of kit. It has its own 460W power supply and is designed to let you install your own PCI-Express desktop graphics card. The Amp also has four USB 3.0 expansion ports, and the devs have simplified the user experience, too.

SMARTPHONES



Samsung Galaxy S7
FROM \$1,049 • WWW.SAMSUNG.COM/AU

Although it was released early in 2016, the S7 has remained the smartphone to beat throughout the rest of the year. Samsung knows how to make great phone hardware and this curvy glass and metal 5.1-inch handset offers all the features you could want (high-res AMOLED display, fast and/or wireless charging, unbeatable camera, it's water- and dust-proof... we could go on) in a svelte package. This is the best smartphone Samsung has ever made – shop around for the best price.



Samsung Galaxy S7 Edge
FROM \$1,099 • WWW.SAMSUNG.COM/AU

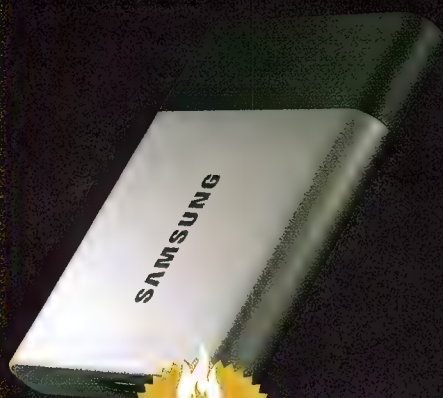
This award should really be going to Samsung's excellent Note 7, but with the latter's tendency to catch fire, we've had to fall back to recommending the S7 Edge instead. This is still a fantastic 5.7-inch phone mind you, with the best phone camera we've tested, a stunning AMOLED display, great performance and pleasingly-premium build quality. Despite its size, in the hand, it doesn't feel as big as a Plus iPhone either. If you like 'em large, look no further.



Motorola Moto G4 Play
\$279 • WWW.MOTOROLA.COM.AU

It's a testament to how far smartphones have come that you can get a device like this Motorola for under \$300. With a 5-inch 720p display, quad-core processor and Android 6.0.1 OS, this has the basics to be a more-than-competent handset, but when you factor in that it's also dual SIM (2G/4G) and that it has a microSD slot and a removable battery, it really stacks up as unbeatable value.

STORAGE



BEST PORTABLE
STORAGE
(PREMIUM)

Samsung Portable SSD T3

FROM \$189 • WWW.SAMSUNG.COM/AU

The SSD T3 is bigger and better than its predecessor, its metal housing making it physically more robust. And it's superfast, with encryption being a seamless affair with the included apps. It comes in four models, ranging from the 250GB to the 2TB storage with a price tag of \$189 to \$1,148, with the two higher-capacity models being the best in terms of value for money. So if you want a fast, tough portable storage device, and willing to pay for it, this one is highly recommended.

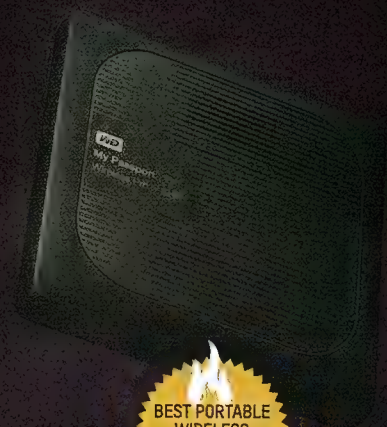


BEST PORTABLE
STORAGE
(BUDGET)

Seagate Backup Plus Ultra Slim 2TB

\$155 • WWW.SEAGATE.COM

Portable SSDs are all well and good, but if you don't need those super-high speeds, a traditional mechanical drive can save you a lot of dosh. This 2TB model from Seagate hits the sweet spot in terms of dollars-to-gigabytes and is reasonably compact, too, with a slimmer body than many of its competitors. It also comes with a respectable software bundle that'll cover basic backup needs for most users.



BEST PORTABLE
WIRELESS
STORAGE

WD My Passport Wireless Pro 3TB

\$449 • WWW.WD.COM

Mostly geared towards content creators like photographers and videographers, many of its features are aimed at making it easy to share large files. It has up to 10 hours of battery and select devices can transfer images straight to the Pro without a PC. Connectivity is great, with a built-in SD card reader and USB host port, providing charging as well. The Pro comes with the Plex Media Server for sharing videos and it's compatible with iOS, Android, Mac and Windows. It's not cheap, however.



BEST 2-BAY
NAS BOX

ASUSTOR AS-3102T

\$359 • WWW.ASUSTOR.COM

This dual-bay NAS is high performing, versatile and affordable. The AS3102T comes with an HDMI port at the back for direct playback of media and can handle 4K resolutions. It has a decent 2GB of DDR3 RAM and offers excellent read and write speeds. It's also very quiet, coming with a low power sleep mode. The direct TV interface is excellent. It has an array of apps for the NAS itself and a range of iOS and Android apps for mobile use.



BEST 4-BAY
NAS BOX

Synology DS916+

\$690 • WWW.SYNOLOGY.COM

The Synology DS916+ is a pricey but performance-oriented NAS with high-end transcoding abilities. It uses the new quadcore Intel Prentium N3710 CPU and is available with either 2GB or 8GB of RAM. It can handle both 2.5-inch and 3.5-inch drives, up to 32TB total. The unit is tool-less, so dropping in drives and setting up is quick and easy. Performance is excellent and the NAS has no trouble extracting top-notch throughput from a Gigabit Ethernet connection.



BEST 5-BAY (OR
BIGGER) NAS BOX

Synology DS1815+

\$1,099 • WWW.SYNOLOGY.COM

The market for super-large NAS boxes, like this eight-bay model, moves a little slower than it does for the more popular two-bay and four-bay models. If you need a butt-load of networked storage, though, this unit is still Synology's flagship and our pick of the super-size options out there. It comes with a full-featured and flexible OS that makes it more like a mini-server than a NAS, and also supports hard drives up to 10TB each.

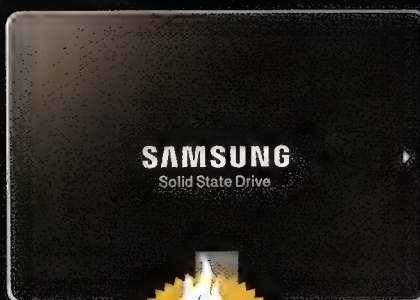
STORAGE



**BEST INTERNAL
SSD (PREMIUM)**

Samsung 960 Pro M.2 (512GB)
\$450 • WWW.SAMSUNG.COM/AU

With the latest Polaris controller chip at the heart of this internal SSD, giving it a 40% increase on speed over its 950 Pro predecessor, the Samsung 960 Pro comes with double the data density along with stellar claimed performance. It can handle random read speeds of 440,000 IOPS and write speeds of 360,000 IOPS. The 960 Pro also matches SATA SSDs for capacity – starting at 512GB and, for the first time with NVMe, 2TB drives in the range as well.



**BEST INTERNAL
SSD (MIDRANGE)**

Samsung 850 EVO (500GB)
\$220 • WWW.SAMSUNG.COM/AU

Samsung hits the target squarely for an affordable SSD that also screams speed. Its CrystalDiskMark scores topped 530MB/s read and 510MB/s write, but it sport speedy 4K-threaded random scores too. The 500GB version delivers in the performance stakes – the benefits of the 3D V-NAND evident in the improved endurance of the drive. While not the cheapest cost per gigabyte, the performance pushes it into the top of our bang-for-buck rating, making it easy to recommend.



**BEST INTERNAL
SSD (BUDGET)**

Crucial MX300 (275GB)
\$125 • WWW.CRUCIAL.COM

The MX300 uses Micron's 32-layer 3D TLC NAND, run by a Marvell 88SS1074 controller. The result is an extremely fast drive on par with the competition, and pushes the SATA 6Gbps connection to its limits. The MX300 supports both AES 256-bit encryption and DevSLP power modes, has a low power draw, and can replace a traditional mechanical hard drive, fitting in either slim or thicker bay drives – albeit with a plastic adapter for the latter.



**BEST INTERNAL
NAS HARD DRIVES**

Seagate IronWolf
FROM \$105 • WWW.SEAGATE.COM

The IronWolf series is aimed at the home and small business user, now available with the addition of a 10TB capacity as well. The 2, 3 and 4TB models run at 5,900rpm, with 64MB of cache, while the 6, 8 and 10TB use 7,200rpm, with 128MB cache and 256MB on the 10TB. The drives are backed by a decent warranty and have a 1 million hour MTBF and handle workloads of 180TB a year – a compelling addition to the consumer NAS options in the market.



**BEST EXTERNAL
DESKTOP STORAGE
(PREMIUM)**

Seagate Innov8 8TB
\$499 • WWW.SEAGATE.COM

The unique thing about the Innov8 is that it's powered entirely by USB, using the USB 3.1 and an 'ignition' startup system. Despite the fact that you will need a computer with a USB Type-C for it to be useful, the performance of this drive is great. If you want sequential read speeds approaching some SSDs, this will get you there. And it comes with Seagate Dashboard, the excellent backup system Seagate provides with all of its external products.



**BEST EXTERNAL
DESKTOP STORAGE
(BUDGET)**

Western Digital My Book 4TB
\$230 • WWW.WD.COM

WD's My Book is an older product – still using USB 3.0, which does make a difference – but it definitely checks out. The drive comes with both SmartWare and the outstanding Acronis True Image software, making the perfect solution for migrating from one system to another, or for keeping a full backup of every file, including program and OS files. If you've got an older system with fewer storage needs, then WD's My Book is a great solution on a budget.



WHAT'S THE NEXT
MUST-HAVE
ON YOUR GADGET WISHLIST?

WAIT NO MORE. GRAB THAT LATEST TECH WITH GREATEST SAVINGS.
WWW.GETPRICE.COM.AU

GETPRICE

Overclocking remastered

An artisan's guide to breaking the hertz barrier with Zak Storey.

The two most important days in a system's life are the day it is born and the day you push it to its full potential. Yeah, okay, that's a slight reworking of a famous Mark Twain quote, but it's inherently true. PCs are designed to be tested. It's that constant striving for more performance, higher clock speeds and greater IPC from generation to generation that propels the computing industry forward under its own momentum.

Consumers want work. We want speed. More performance, quicker load times, faster renders at higher qualities. That's what it's all about. Now, how do you get the most out of a processor? You overclock it. We'll discuss

some with its caveats — power draw, in particular — but in our eyes, the positives far outweigh the negatives. And to those naysayers ready to peddle with statements like, 'Are you really going to gain a much more 100 points in Cinebench?' or 'It's just not worth the extra power,' we're here to tell you that's pure hogwash.

Why? Simply put, the benefits of CPU overclocking in the workplace environment are huge. Going from 4.0GHz to 4.06GHz on an Intel Core i7-6700K, for example, can shave off a sweet 20% when it comes to video rendering times. In contrast to running at stock it doesn't sound like much, but if you can render an average 10-minute 4K video, that's like an hour for you.

That's 1.2 hours saved on a single run. Do that three times a week, four times a month, for a year, and all of a sudden you've saved more than a day working on your content. That's a pretty big deal in our eyes. To say overclocking is pointless is the equivalent of saying that pursuing advanced processing speed is pointless.

Of course, with CPU overclocking, that is centered entirely around the primary purpose of gaming, and increasing those main frame rates — but that's something we'll touch on a little later. So what do you need to overclock? What do you need to ramp up that frequency? And what can you do to make your overclock stable — the process? Read on.

What to expect when overclocking

You've selected your hardware, you've chosen your overclocking-capable chip, now you need to do some research on your core and how well it's going to clock. On top of your processor, you'll notice a string of numbers — this is known as your chip's batch and indicates which silicon wafer your chip is derived from. A quick Google search often provides forums where other enthusiasts are benchmarking cores from the same wafers, giving you a rough estimate of how yours will perform.

It's also worth doing some general research. Fortunately for the consumer, you have the advantage of reviews coming out ahead of time, indicating what you can expect in terms of overclocking potential. Getting a good grounding and idea of just how far your chip will go not only gives you suitable targets to aim for, but also a sensation of just how lucky you can be.

MOTHERBOARD SELECTION TIME

Your choice of motherboard is one of the factors that tends to vary the most

when it comes to the overclocking experience, either through hardware choices, UEFI BIOS or general stability. Everyone has a particular brand of motherboard they enjoy overclocking on. For us here at APC, it's ASUS — the clean and crisp BIOS, coupled with a plethora of additional settings, means we have full access to a wide range of overclocking features that are sometimes ignored, locked or often not included with other brands. That's not to say that you'll find the highest overclock records here, but generally speaking, for the everyday user, who only has access to one processor, you can usually get some seriously impressive performance out of an ASUS-branded motherboard.

Outside of UEFI BIOS, overclocking profiles and settings, motherboards control how the voltage reaches your processor. The eight-pin EPS power provides juice straight to the processor, which is converted via the voltage regulator modules (VRMs), by using a combination of pulse width modulators (PWMs) and metal oxide semiconductor field effect transistors

(MOSFETS), from the 12V power down to 1.2V VID that the CPU needs to operate.

AUTOMATIC VS. MANUAL

What we're talking about here are automatic overclocking profiles and features. ASUS has its AI Tuning, MSI its Game Boost technology, ASRock its preset profiles — you name it, if a motherboard manufacturer has a Z170 mobo, it's likely there's an accompanying, well trademarked form of automated overclocking.

In theory, these are great; an easy way of gaining a 10–20% increase on your clock speeds. That said, there are always going to be limitations, and these automatic features almost always apply more voltage than is strictly necessary. For instance, our auto ASUS AI Tuning applies a Vcore of 1.34V, allowing us to get an overclock of 4.3GHz. In contrast, we can do the same overclock with a meager 1.31V on the Vcore, reducing overall temperatures by 10°C, while still retaining stability.



Requisite hardware

To the initiated, you're well aware that you need specific hardware to make any overclocking ambitions a reality. You can't get away with a stock cooler and mediocre power supply in this day and age. In fact, there's more to it than that. From the outset, you need to plan your build ahead of time for overclocking, if it's something you want to pursue. There are degrees of preparation, of course. You can either opt to go the whole hog and purchase an AIO or a fully custom loop, or just purchase a K series processor and wait until a little later on in your rig's life cycle before taking the plunge into overclocking.

"If you plan on doing this at home, you need to ensure you have a suitable chassis with decent internal airflow."



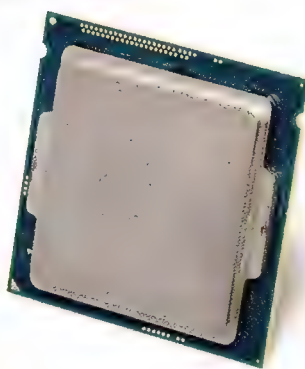
MOTHERBOARD

Next on the list is your motherboard. Overclocking is more often than not locked to the higher-end chipsets — for Skylake that's Z170, and for HEDT, well, everything is overclockable. It's worth noting that the more expensive overclocking motherboards do help, because they generally tend to have better power phase designs, ensuring a more consistent voltage is provided to your processor.

CPU

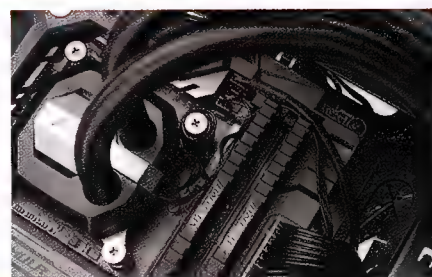
As an aside, you need a processor that's capable of overclocking, too, of course. Any of Intel's 2011 Extreme Edition processors are capable of overclocking, but for the more mainstream of us, you're looking for anything with a K after the name, indicating that the multiplier is unlocked.

This boils down to an Intel Core i5 or a Core i7, depending on your budget. Generally, Intel's i7 series tends to be clocked far higher than the i5 by default, but both often overclock to the same maximum.



PSU

PSU choice is the easiest to mess up and the worst to get wrong. The general rule of thumb is that you want around 20% leeway over what your system actually draws from the wall at peak load while overclocked. So if an overclocked system draws 450W, you want a PSU that's rated for around 550–600W. On top of that, you want to spend at least \$150 on it, and get a Gold rating or higher, purely from an efficiency standpoint. You can do it with a lower rating, but you will be drawing more power from the wall when overclocking, and the greater efficiency will save you money in the long run. Never skimp on this, because it can take most of the system down with it if it goes wrong.



CPU COOLER

Another essential item you need is a sufficient CPU cooler. The latest generation of overclockable Skylake and Broadwell-E processors come without a retail cooler. The theory being that if you're going down the overclocking route, you're going to be looking for something capable of expelling all that excess heat.

As you add more volts to the core, the processor generates more heat. And in doing so, the processor is far more likely to hit its TJMax — or junction temperature maximum.

You can either choose a proper-sized full tower cooler from the likes of Noctua, Be Quiet! or CoolerMaster, or go for an AIO closed-loop cooler from Corsair, NZXT, EKWB or any number of others.



WHAT WE'RE USING

In this feature, we're going with an Intel Core i7-6950X, an ASUS X99 Strix Gaming motherboard, 32GB of Crucial Ballistix Elite DDR4 @ 2,666, a NZXT Kraken X61 AIO cooler, coupled with two Noctua NF-A14 iPPC fans on an open-air test bench.

If you plan on doing this at home, you need to ensure you have a suitable chassis with decent internal airflow. A positive air pressure system is advised, but balanced is just fine, and preferably do your overclocking somewhere cool, because ambient temperatures have a substantial impact on your overall overclock potential. Ideally, you ought to be practicing your overlocks at an ambient temperature of around 21°C or lower.

Overclock your CPU

1 GRAB THE SOFTWARE

So you've got your system set up and running at stock. Now it's time to crank up the volts and get that processor as high as it'll go. First thing you need to do is download a few programs. You're going to want to get something to provide you with a base number for performance — Cinebench R15 is quick, free and a good indicator of rendering prowess. Next up, you need a synthetic benchmark — Prime95 or OCCT are two brilliant examples of this. OCCT, in particular, also stress tests memory channels at the same time. And lastly, you need two more programs — one to measure Vcore and one to measure temperature.

We suggest CPU-Z for voltage and hertz monitoring, and HWMonitor for temperatures. Although HWMonitor also measures voltages, it's far easier to see what you're looking at with CPU-Z.

2 RUN PRELIMINARY TESTS

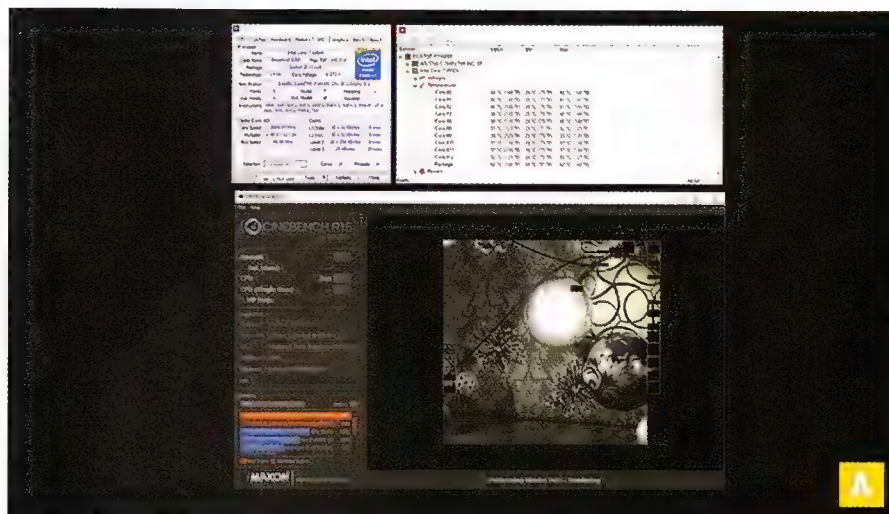
After downloading and installing your benchmarking software, you need to get some preliminary figures. It's best to note these down, or create a spreadsheet where you can document what voltage you're applying, to what multiplier and what your scores, temperatures and stabilities are on each attempt. This way, you won't forget and can refer back to it later on. To begin with, open up CPU-Z and HWMonitor, then open Cinebench R15, and run the CPU test three times in conjunction [Image A]. Mark down all three of these scores, and take the average of them — this is your starting point. It's also best to note what your maximum core temperature is; ideally, you're looking for anything under 55–60°C. Finally, note the maximum voltage CPU-Z is registering during the benchmarks.

3 ENTER THE BIOS

Once you've got those early tests out the way, jump into the BIOS. We're using the ASUS RoG STRIX X99 Gaming motherboard's BIOS. It's identical to the Z170 platform, as well as the other brands in ASUS's arsenal, but with a black and red skin. Restart your system, and mash the Del key to get into the BIOS. Hit F7 to get into Advanced mode. Then head across to AI Tweaker.

4 YOUR INITIAL OVERCLOCK

Once you're in AI Tweaker, it's important to set up your memory so it's running at its optimal frequencies.



Hit the 'AI Overclock Tuner' tab, and select 'XMP' from the drop-down menu. You'll want to start with an initial overclock [Image B]: Go to 'CPU Core Ratio' and select 'Sync All Cores'. Input a slightly higher multiplier. So if you have a Core i7-6700K reading '42', input '44'. Hit F10, save and reboot, then head to the desktop to see if it's stable. At this point, it's not worth messing with voltages.

5 THE STRESS TEST

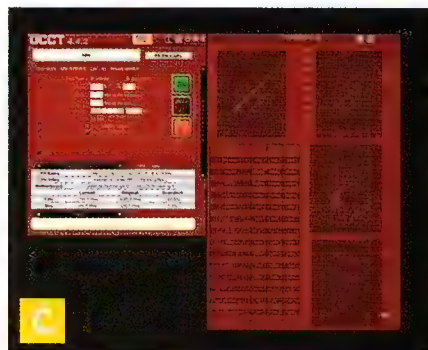
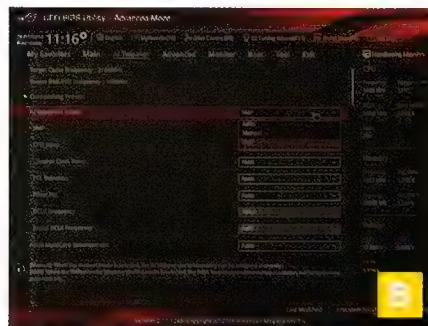
Now repeat what you did with your preliminary tests. If the system is stable, great — you're on to a winner. Head back into the BIOS and increase the multiplier once more. You want to keep doing this process until the system locks up.

6 INCREASE THE VOLTAGE

Now you've hit the limits of the base voltage, you want to start increasing the voltage to the CPU to overcome those stability issues. This is where you start to see a substantial increase in overhead temperatures. Head back into the BIOS, to AI Tweaker, then scroll down until you see 'CPU Core Voltage', and change it to 'Manual Mode'. Now, with your voltage noted down from earlier, change the 'Voltage Override' from 'Auto' to a setting slightly higher than that. We suggest increasing Vcore by 0.05 at a time — do this until the overclock holds through Cinebench R15. Then it's just a case of rinsing and repeating, slowly increasing the multiplier and Vcore side by side until the system is stable.

7 YOUR FINAL OVERCLOCK

Eventually, you reach a point where both temperature and stability become an issue. If you've been noting

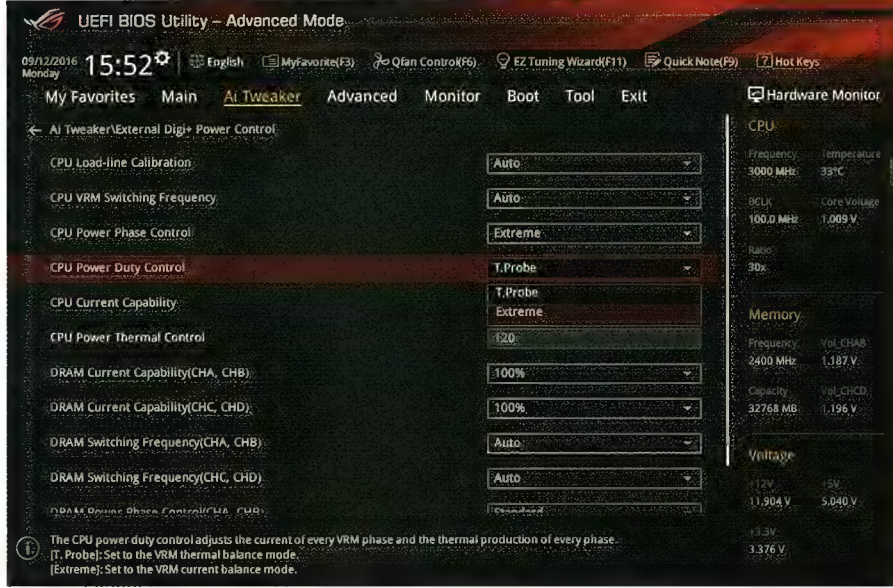


down all these figures on a spreadsheet, this'll come in handy for the next bit. Ideally, you're looking for temperatures around 70–80°C under load. The reality is you'll probably hit silicon instability long before you reach TjMax. At this point, you want to dial it back down one setting to the last stable frequency [Image C]. After which, do a full system stress test by running a synthetic benchmark for anywhere from 1 to 24 hours, depending on your patience. We suggest OCCT here, because it also saturates the memory channels effectively. If you do run into any trouble, add a little extra voltage or reduce the multiplier a fraction to compensate.

Tips & tricks to push it further

There are a few tricks to make your overclock go a little further. Head back into the BIOS, to AI Tweaker, then go to 'External Digi+ Power Control'. You'll find three settings we can adjust to improve overclocking performance for the latest ASUS motherboards. First, disable 'VRM Spread Spectrum'. This stops the VRMs from attempting to reduce any electromagnetic interference by fluctuating the base clock of the processor. Nowadays, you shouldn't have a problem disabling it, unless you work with highly sensitive audio equipment. Next up is 'CPU Power Phase Control' – change this from 'Auto' to 'Extreme'. This ensures you use the full number of power phases on the board, meaning less stress on the MOSFETs, and more long-term stability. Down from that is 'CPU Power Duty Control' – change this from 'T.Probe' to 'Extreme'. This stops the mobo balancing the power load based on VRM temperature, and instead focuses on splitting the current evenly across all the MOSFETs.

This last setting is well worth it. Intel processors have a particular piece of software called SpeedStep. What this does is fluctuate the multiplier and voltage going into the processor,



depending on the load on the CPU. Most overclocks fail not as the processor is at 100% load, but as the multiplier and voltage increase up to the settings you've put in place while under load. Disabling SpeedStep ensures the processor is constantly running at the frequency and voltage you set it. Don't panic, though – this

doesn't mean you'll be running at 80°C constantly, because the CPU still abides by the laws of load, meaning although temperatures may be fractionally higher, the core won't get hot until under load as usual. Unfortunately, you will be drawing more juice from the wall, but that's part and parcel of overclocking anyway.

CPU BENCHMARKS

	INTEL CORE I7-6950X STOCK	INTEL CORE I7-6950X OVERCLOCKED	INTEL CORE I7-6950X UNDERVOLTED
TECHARP X264 V5.0.1 (FPS)	38.62	46.82	38.58
CINEBENCH R15 SINGLE CORE (INDEX)	145	142	130
CINEBENCH R15 (INDEX)	1,839	2,186	1,833
3DMARK FIRE STRIKE ULTRA (INDEX)	5,190	5,232	5,228
TOTAL WAR: ATTILA @ 1080P (FPS)	41/57	48/59	43/58
RISE OF THE TOMB RAIDER @ 1440P (FPS)	16/44	16/44	21/44
SYNTHETIC POWER DRAW @ LOAD (WATTS)	245	324	185
TEMPERATURE @ LOAD (DEGREES CELSIUS)	61	82	46
CORE FREQUENCY AND VCORE	3.5GHZ @ 1.11V	4.3GHZ @ 1.31V	3.5GHZ @ 1.01V

Our testbed consists of an ASUS X99 Strix Gaming, Nvidia GeForce GTX 1080, 32GB Crucial Ballistix Elite @ 2,666MT/s, 500GB Samsung 850 Evo, 1TB Samsung 850 Pro, Be Quiet! Dark Power Pro Platinum 1,200W PSU, and an NZXT Kraken X61, plus 2x 140mm Noctua NF-F12 iPPC fans. For our full system overclocked, we cranked the Core i7-6950X up to 4.3GHz at 1.31V, and increased the core clock by 200MHz and the memory by 450MHz on the GeForce GTX 1080.

CPU BENCHMARKS

	NVIDIA GTX 1080 STOCK	NVIDIA GTX 1080 CORE OC ONLY	NVIDIA GTX 1080 CORE AND MEMORY OC
3DMARK FIRE STRIKE (INDEX)	17,313	18,978	19,348
FAR CRY PRIMAL @ 1080P (FPS)	58/94	72/108	71/111
3DMARK FIRE STRIKE EXTREME (INDEX)	9,563	10,356	10,870
FAR CRY PRIMAL @ 1440P (FPS)	58/77	67/80	65/84
TIME SPY DX12 (INDEX)	7,205	7,707	7,970
FINAL GPU BOOST CLOCK (MHZ)	1,873	2,126	2,088
FINAL MEMORY CLOCK (MHZ)	5,005	5,005	5,508
TEMPERATURE @ LOAD (DEGREES CELSIUS)	77	86	85
GAMING POWER DRAW @ LOAD (WATTS)	313	337	336

Our testbed consists of an ASUS X99 Strix Gaming, Nvidia GeForce GTX 1080, 32GB Crucial Ballistix Elite @ 2,666MT/s, 500GB Samsung 850 Evo, 1TB Samsung 850 Pro, Be Quiet! Dark Power Pro Platinum 1,200W PSU, and an NZXT Kraken X61, plus 2x 140mm Noctua NF-F12 iPPC fans. For our full system overclocked, we cranked the Core i7-6950X up to 4.3GHz at 1.31V, and increased the core clock by 200MHz and the memory by 450MHz on the GeForce GTX 1080.

GPU overclocking: worth the bother?



You've got the processor out the way, so what's next? Memory aside (we'll cover that later), it's all about the graphics card. For gamers, this piece of hardware is crucial when it comes to pumping out frames. Most graphics cards are capable of being overclocked — some are designed for it, others less so. Overclocking a GPU generally increases average frame rates, but more importantly, minimum frame rates, too. So you'll have a smoother experience and, in the heat of battle, screen tearing won't become another nemesis.

BACK TO THE BLACKBOARD

Overclocking a GPU shares a lot of similarities with overclocking a CPU. Generally, you should always start at the same point: research. Know what your GPU is capable of, what architecture it's built from, and how well it overclocks. Unlike CPUs, GPU architectures vary wildly in overclocking potential.

We're using a reference Nvidia GeForce GTX 1080, with the Pascal architecture, which is very similar to the overclocking king, Maxwell, or the 900 series.

OC PROFILES AND PRE-BINNED CHIPS

Are OC profiles worth it? Well, similar to the automatic versus manual debate earlier, these profiles differ very little. ASUS, MSI, Gigabyte and EVGA set out a specific speed profile for each generation of card ahead of time, and bake it into some form of GPU overclocking software. This can work well, if you're lucky with the silicon

lottery, but can fall flat if the processor doesn't hold well, and you end up with a card incapable of meeting its slightly overcompensating overclock profile. There's often no difference between a pre-overclocked GPU and a standard one — you're probably just applying a more aggressive overclock profile than you need.

Then there's pre-binning. All chips are binned upon manufacture. Think of those silicon wafers: Each one houses an entire generation of processors, because location and variance within the silicon dictates which chip is what. The middle of the wafer is always better quality than the edge. And this is where the manufacturer discerns which processors will be 1080s, 1080 Tis, or Titans. These are sold to aftermarket partners. Now, these manufacturers can either just place them in the cards that they're assigned to, or bin them further. To do this, they test which cores leak the most voltage, which chips require the least volts to operate, and which chips overclock the highest. The very best go into the high end 'premium' cards, such as EVGA's FTW cards, while the lesser ones go into more mid-range and reference cards.

COOLING AND AIB PCB

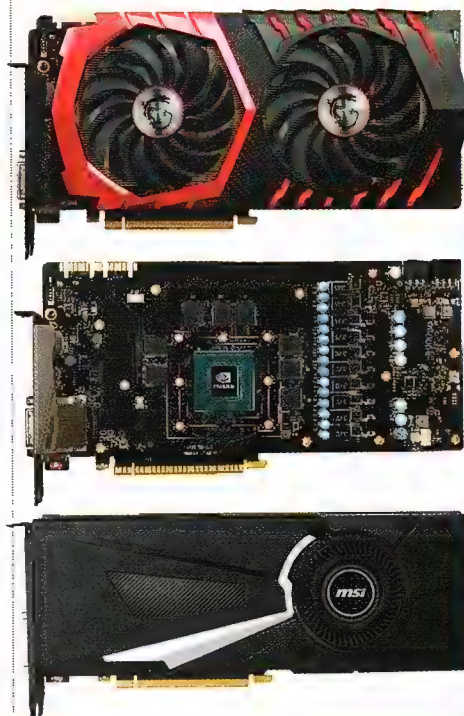
You also need to consider what style of card you want as regards cooling. There are four styles. The standard blower design features a single intake fan, drawing air into an enclosed shroud, pushing it through a heatsink, and out the back of the rear I/O — brilliant for cases with limited space. Then there are the dual- or triple-fan

dissipation cards. These are often found on the heavy hitters — ASUS's DCU III, Gigabyte's Windforce and MSI's Twin Frozr are good examples. These cards draw air in and around via the main fans, push it down through a heatsink and out into the surrounding case, and are often quieter and cooler than their blower counterparts.

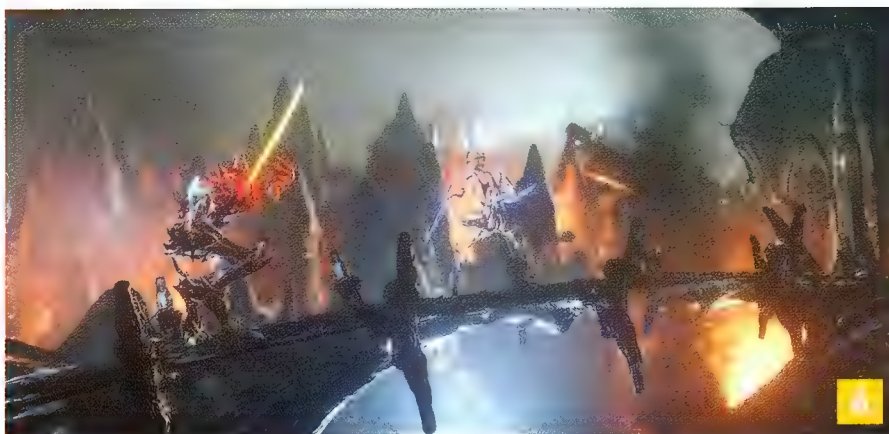
Lastly, you get the fully water-cooled cards. These either come as a closed-loop card, such as the Fury X, or with preinstalled water blocks, such as the EVGA Hydro Copper, requiring you to insert them into a custom water-cooled loop. And on top of all that, there are the miscellaneous hybrids, often utilising a combination of both air and water cooling.

There are aftermarket cards touting more advanced PCB solutions, too. These often include more advanced MOSFETs and chokes, in combination with a better power phase design, meaning better overclocks and higher performance as standard.

"Overclocking a GPU shares a lot of similarities with overclocking a CPU. Generally, you should always start at the same point: research."



Overclock your GPU



1 MORE PROGRAMS

Similar to CPU benchmarking, you need to download some software to get this baby started. Firstly, download GPU-Z – this program tells you exactly what GPU you have, and all of its stats, and also monitors maximum boost clock, memory frequency and temperatures. You also need a quick synthetic benchmark, such as Furmark, to synthesise load, a more in-depth 3D benchmark, such as Fire Strike [Image A], an in-game benchmark (that's *Far Cry Primal* for us), and a program to overclock with. For Nvidia cards, we suggest using MSI Afterburner; for AMD, either use the integrated Wattman overclocking utility in Crimson, or Sapphire's TriXX software, depending on what you have available for your card. In this instance, we're overclocking the Nvidia GTX 1080, but the principles apply across both brands.

2 MORE PRELIMINARY TESTS

We want to benchmark the card at stock, and note down how the card performs in a spreadsheet. So open GPU-Z, click the 'Sensors' tab, click the drop-down arrow on 'GPU Core Clock' and select 'Show highest reading'. Do the same for 'GPU Memory Clock'. Now open Fire Strike and run the standard benchmark at least twice. Note what GPU-Z states for the highest Core and Memory Clock frequencies [Image B]. This is how far GPU boost is pushing your core at stock. Note the average Fire Strike score, then run your in-game benchmark and take note of that as well. You can also write down the temperatures here (check GPU-Z), but you'll run into silicon limits long before thermal ones.

3 RAMP IT UP

Open up MSI Afterburner and increase 'Power Target' to the

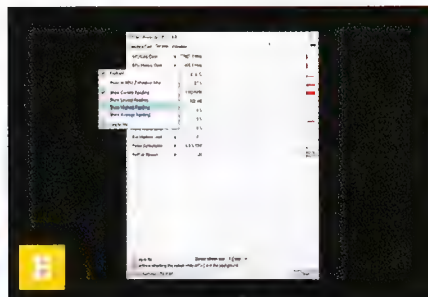
maximum. Don't worry about it increasing 'GPU Temp Target', as it's still well within operating parameters. Next, start increasing 'GPU Clock Offset'. To begin, increase it by 50MHz, and hit 'Apply'. Open up Furmark and set it to a resolution appropriate to your card (we're looking to emulate 100% load without stuttering). For our GTX 1080, that's 2,560 x 1,440 at an AA setting of x4. Run 'GPU Stress Test' and see if Furmark or the screen locks up. If it's still stable after three minutes, increase the clock offset by another 50MHz. Keep doing this, making notes, 'til you lock up.

4 CIRCUMVENT VOLTAGE ISSUES

Now you need to overvolt the card to pump the core clock higher. In MSI Afterburner, go to Settings, check 'Unlock voltage control' in the first tab, then change the drop-down to your type of card. Go back to the main interface, add 10mV/10% extra on the overvolt section, and try your overclock again. If this doesn't work, keep adding voltage until you get to around +40% – anything higher and you'll probably see stability issues. After that, it's a case of finding the sweet spot for the core clock. Increase or decrease by 10MHz until you find the GPU's limits.

5 CHECK FOR GRAPHICAL ANOMALIES

Now we have a stable overclock with Furmark, see how it holds up in a more intensive benchmark. Open Fire Strike and run a single instance. You need to watch this. In particular, you're looking for anything that shouldn't be there: graphical anomalies, such as flickers, green or purple particles, anything that isn't in the original. To save time, go to the custom settings and run Scene 2 or Scene 4, as they're the most graphically intense.



6 ALL ABOUT THAT MEMORY

To complete your overclock, improve the VRAM. To do this, go back into MSI Afterburner [Image C] and slowly increase the memory clock, again by 50MHz at a time. Generally, VRAM tends to be predictable about how high you can clock it: GDDR5 and 5X averages an increase of 400–500MHz, while HBM usually manages about 50MHz before it starts to fall over. Once this is done, and Furmark is still responsive, go back into Fire Strike and look for anomalies again. Fortunately, memory overclocks tend to be more aggressive in how those anomalies appear. If you're having trouble, drop down the memory clock by 10MHz each time, until you manage to get it stable. If you're still having trouble, and you've dropped down by 200MHz or more, try going back up, but reduce the overclock on the core by 10MHz at a time instead.

7 TRIAL AND ERROR

GPU overclocking is always trial and error. Because there are two different components to overclock, it can take time, but once you've got a stable profile dialed in, you're good to go. Save the profile in MSI Afterburner, note it down in your spreadsheet and crack open GPU-Z once more. Set the sensors we changed earlier back to the highest reading. Run Fire Strike two or three times, plus your in-game benchmark and you should see a marked improvement over your stock settings.

Overclocking your RAM

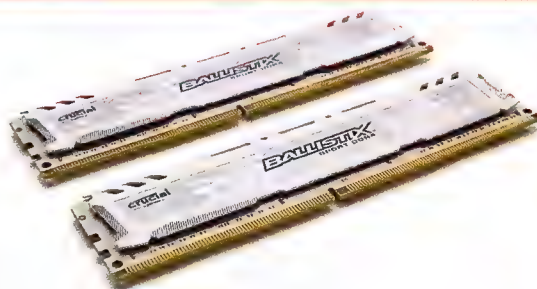
Modern CPUs have plenty of memory bandwidth, so it's rare that your CPU will be starved on this front. But even so, you can overclock your memory if you want. As the two are linked, doing so may mean you have to ease back on your CPU clocks, but for a memory-centric task, it may be worth it.

To overclock your RAM, you need to pop into your UEFI BIOS utility, and select the 'DRAM Frequency' — base it on the memory's recommended specs, and increase gradually until it becomes unstable.

You need to get the latency right, too, because a higher frequency with poor latency yields worse overall performance.

For most normal use, though, you'll just want to run your memory at the stock frequencies. Here, you can either go for the 'safe' JEDEC settings, or push the boat out and go for a supported XMP profile. If you experience any problems with memory (Windows will throw up

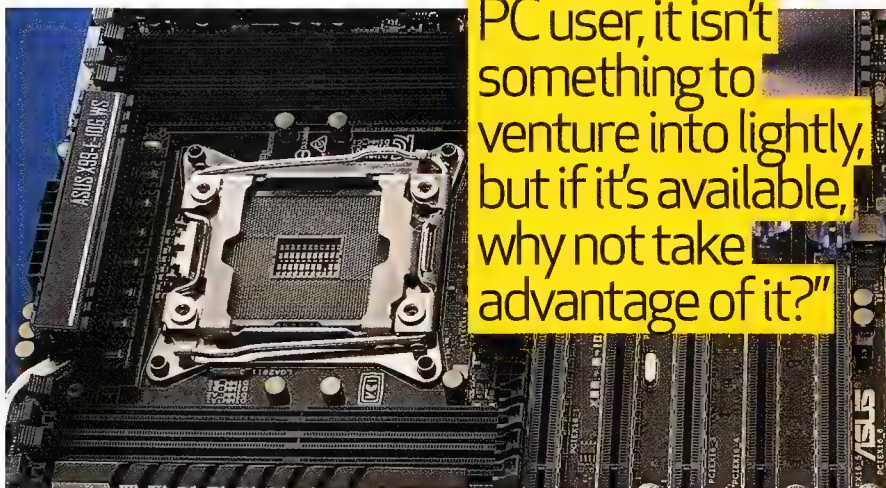
a memory error), pop into your BIOS and go for a safe stock frequency setting. You'll barely see a difference in the real world either way.



Is overclocking worth it?

It's a tough question to answer, and depends on your circumstances. Without doubt, overclocking is extra performance for free. It's an interesting pastime for those looking to broaden their custom PC building knowledge, and nowadays it's quite safe, too. There's always going to be drawbacks, though: the additional power draw is something we can't ignore, and heat dissipation does need to be addressed. That said, in our opinion, pushing hardware to the limit is why we're here, and what we enjoy doing most. For the average PC user, it isn't something to venture into lightly, but if it's available, why not take advantage of it?

That said, the computing world doesn't always revolve around more power and more performance. If you're looking at reducing the overhead temperatures and noise inside your case, undervolting may also be a solution. Intel has always been extremely conservative with the base VID that it applies to its processors upon leaving the manufacturing houses, and for many a chip, they're far higher than



"For the average PC user, it isn't something to venture into lightly, but if it's available, why not take advantage of it?"

what's actually necessary to keep it stable — depending, of course, on your luck in the silicon lottery. Just take a look at our benchmarks on page 68 and you can see that by reducing our core voltage by just 0.1V, we managed to decrease our average temperature by 15°C, while still retaining a perfectly stable overclock, with minimal impact on performance.

All in all, if you have a K or X series chip, and you're not messing around with the voltages and frequencies, you're genuinely missing out. The world of overclocking can be fraught with thrills and frustration, but that feeling you get when you have finally dialed in the maximum for your processor is second to none.

FULL SYSTEM BENCHMARKS

	STOCK SYSTEM	OVERCLOCKED CPU & GPU
CINEBENCH R15 - MULTI CORE (INDEX)	1,839	2,199 (20%)
3DMARK FIRE STRIKE EXTREME (INDEX)	9,563	11,006 (15%)
TOTAL WAR: ATTILA @ 1440P (FPS)	40	45 (13%)
RISE OF THE TOMB RAIDER @ 1440P (FPS)	44	48 (9%)
GAMING POWER DRAW @ LOAD (WATTS)	313	373 (19%)

Our testbed consists of an ASUS X99 Strix Gaming, Nvidia GeForce GTX 1080, 32GB Crucial Ballistix Elite @ 2,666MT/s, 500GB Samsung 850 Evo, 1TB Samsung 850 Pro, Be Quiet! Dark Power Pro Platinum 1,200W PSU, and an NZXT Kraken X61, plus 2x 140mm Noctua NF-F12 iPPC fans.

For our full system overclocked, we cranked the Core i7-6950X up to 4.3GHz at 1.31V, and increased the core clock by 200MHz and the memory by 450MHz on the GeForce GTX 1080.

howto

» QUICK TIPS

Experts solve your computing problems

APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

WINDOWS

UNINSTALLING A ROGUE PROGRAM

After installing a program in Windows 10, my computer has slowed to a crawl. How can I get this off my PC when everything keeps hanging and crashing?

Jake Palmer

Click the Start button, then hold the Shift key as you select 'Power > Restart'. This will bring up the 'Choose an option' screen. Select 'Troubleshoot' followed by 'Advanced options' and finally 'Startup Settings'. Click 'Restart' and the boot menu will appear – press F5 to access 'Safe mode with Networking'. Once in Safe mode, remove the programs you suspect are cluttering up your PC by right-clicking the Start button and choosing 'Programs and Features'. While you're here, we'd also suggest you run full scans with your security tools to verify there's nothing nasty going on behind the scenes – note, they won't be running automatically, so you'll need to launch them from the 'Start > All apps' menu. One final check – open File Explorer, right-click your system drive and choose 'Properties > Tools' tab. Click 'Check' followed by 'Scan drive'. If any issues are found, they should be fixed on the next reboot.

Nick Odantzis

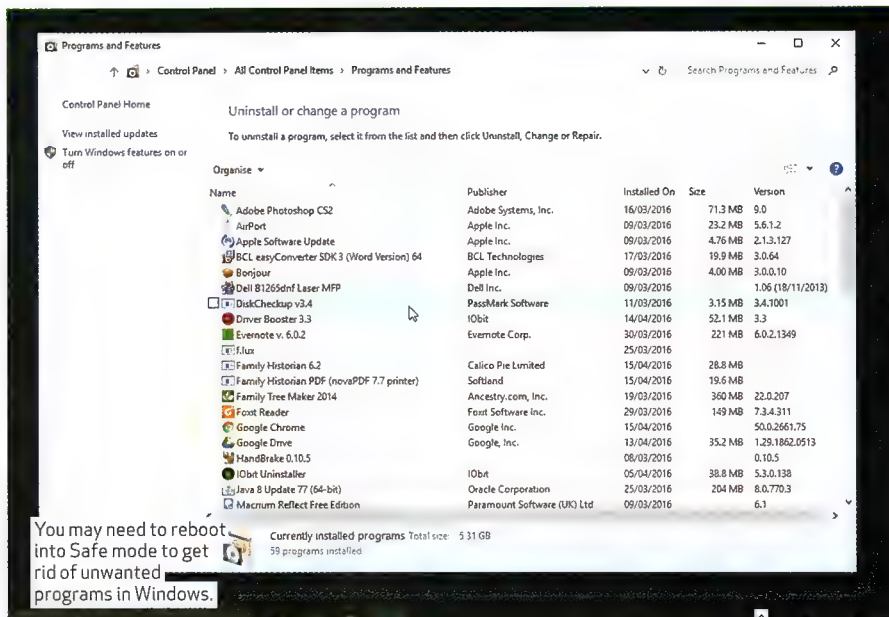
SECURITY

WINDOWS 95 SECURITY

APC, I'm in trouble. My Dell Inspiron 800 with a Pentium-class processor and 60MB hard drive, running Windows 95, is stuck at the log-in screen. I haven't used it in more than two years, and I've forgotten the password. I stopped using it because it was showing the symptoms of a virus, but Norton Antivirus couldn't find anything. Is it possible to recover or clear my password so I can create a new account, perform a controlled upgrade, and recover my data? I have Windows 7 and Windows 8 upgrade discs. Or should I upgrade to Windows 10?

David Plotke

Let's start with your first issue: getting into Windows 95 so you can recover whatever information might be on that hard drive. When prompted to log in, press Cancel instead. This



"We'd also suggest you run full scans with your security tools to verify there's nothing nasty going on behind the scenes."



should get you into the operating system, albeit without network access. Hit Start, then Find. Search for all files with the *.pwl extension, then delete them. The next time you go to log in, the password should be blank.

Once you grab those files, find the nearest recycling centre and drop that Inspiron off. Surely it's approaching 20 years old, right? Windows 7 requires a DirectX 9-class graphics device, and it's probable that you don't have the requisite 1GB of RAM installed. Windows 8 asks for processor features your Pentium lacks. You get the idea. No modern OS will run sufficiently well to make an upgrade worth attempting – and that's assuming your 60MB hard drive is really a 60GB repository.

APC team

MEDIA

MP3 METADATA IN A SNAP

I've got a load of MP3 files I'd like to add the correct metadata (artist, track, album cover and so on) to. What's the best program for quickly adding this information?

Bob Collins

Download MP3tag from www.mp3tag.de/en – this allows you to add metadata for one or more tracks quickly and easily (for example, select all your tracks and quickly apply universal information such as album artist or title). There's also a handy tool should your filenames include the artist and track information. Select 'Convert > Filename – Tag'. Adapt the 'Format string' box as required – use the '/' button to add extra elements. A handy preview quickly reveals if you've got the right data selected – click 'OK' to apply the tags.

Cat Ellis

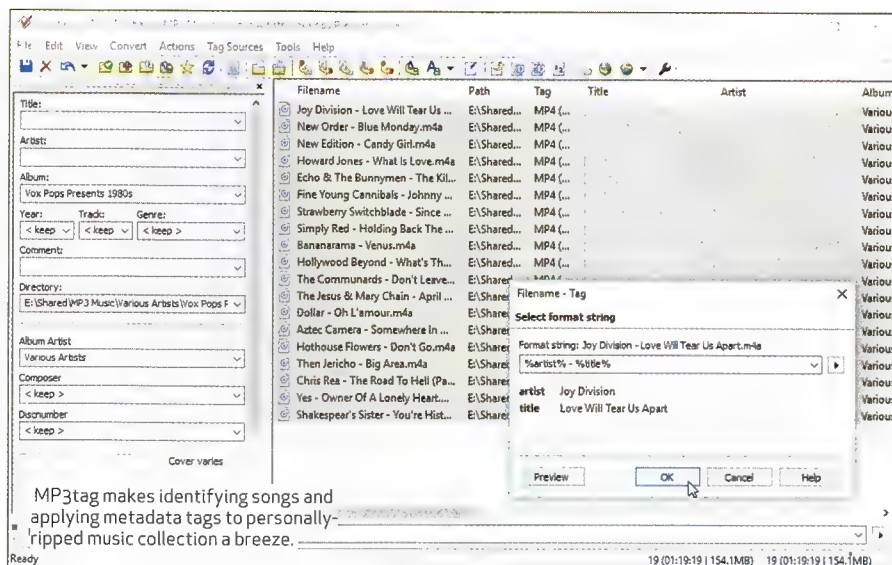
ADMIN

EASY REMOTE MANAGEMENT

I'm sure I'm like many of your readers in the fact that, as the known 'tech guru', I've ended up being the default tech support for friends and family – and my mother in particular. What's the easiest way of remotely managing her PC?

Rufus Cox

For a quick and simple option, we'd suggest Google Chrome's Remote Access Desktop extension. You'll need to install Chrome on your mum's PC (chrome.google.com), plus log into your own Google Account in Chrome on that PC – set up a separate user for yourself if necessary. Once set up, you won't need Chrome to be running or be logged into Chrome, as your user for the feature to work. Here's a detailed step-by-step guide to getting it up and running:



MP3tag makes identifying songs and applying metadata tags to personally-ripped music collection a breeze.

1. Sit at the PC you wish to control. Click the user name and choose 'Switch person' to sign into your Google Account. Type `chrome://extensions` into the Address Bar, then click 'Get more extensions' to find and add Chrome Remote Desktop.

2. Next, type `chrome://apps` into the Address bar and select Chrome Remote Desktop. Follow the prompts to authorise it and link it to your Google account. Once done, click 'Get started' under 'My Computers' followed by 'Enable remote connections'.

3. Now, install the desktop host by selecting 'Accept and Install' to download the host installer. Double-click this and follow the prompts to install it and set up a six-digit PIN for secure access – you'll need this each time you attempt to connect from your PC.

4. If you've set up browser syncing on your own PC, the Chrome Remote Desktop will automatically be installed when you next open Chrome. Repeat step two, then click 'Enable

remote connections' and select your remote PC to connect and take control.

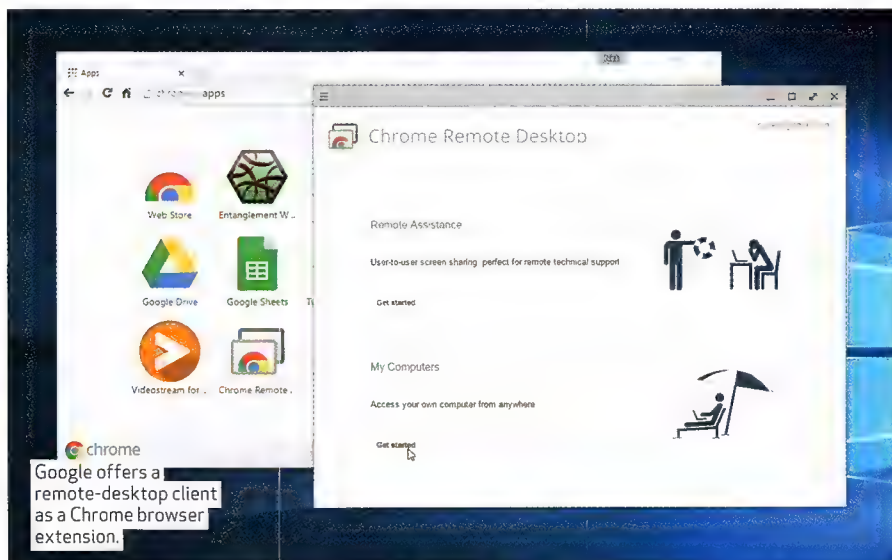
HARDWARE

SURFACE STYLUS STOPPED WORKING

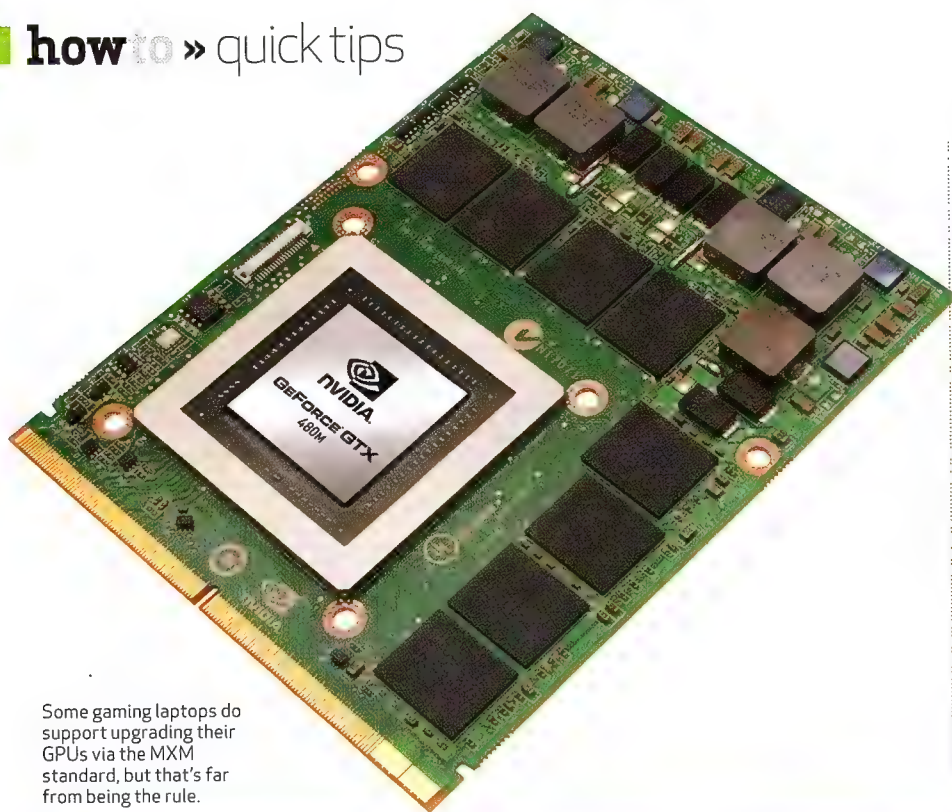
The stylus on my first-gen Surface tablet has stopped working. I've checked the power function for USB/HID connections, but can't seem to fix the problem.

Theresa McHugh

If you've not performed a full power shutdown for a while, start by shutting down the Surface normally using its power button. Then when it's off (or apparently off), press and hold both power and volume-up buttons together for a minimum of 15 seconds. Once done, release the buttons, leave the Surface for 10 seconds, then power up normally – this should fix the problem. If it doesn't, try the full power off again, but after 10 seconds, hold the volume up button while you press and release the power button. When the Surface logo appears, release the volume button and you should enter the BIOS – from here,



Google offers a remote-desktop client as a Chrome browser extension.



Some gaming laptops do support upgrading their GPUs via the MXM standard, but that's far from being the rule.

"You'll encounter the fewest compatibility problems and enjoy the best possible performance by going into the BIOS and setting your Option ROMs to UEFI mode."

you should be able to verify that the stylus is working, and on rebooting from here the problem should be solved.

Matt Hanson

HARDWARE

M.2 FRUSTRATIONS

Back in November last year, I purchased an ASUS Z10PE-D8 WS workstation motherboard that theoretically supports bootable M.2 drives. However, I've spent

hours on the phone with company reps and a couple of techs, and I've scoured the internet collecting information on how to configure this board so that Windows 7 sees the M.2 SSD as a bootable device, all to no avail.

At this point, I'm ready to clean it up, take pictures, and put it on eBay for sale at a cut-rate price. I am using a Samsung SM951 purchased online. And I have used this M.2 SSD in two other machines hosting ASRock X99 OC Formula and MSI

A full shutdown and reboot should resurrect your Surface stylus.



Getting M.2 drives to boot older operating systems can sometimes be problematic.



X99 Mpower motherboards, both without any issues. Any suggestions?

Irvin J. Halter

Our first (and no doubt unpopular) suggestion would have been to give Windows 10 a try. However, he wanted to get a more technical explanation straight from the source. ASUS's representatives responded with the same advice, though. You'll encounter the fewest compatibility problems and enjoy the best possible performance by going into the BIOS and setting your Option ROMs to UEFI mode in the Advanced tab's 'CSM Configuration' menu and going from there. That's not to say the Z10PE-D8 is blameless for your frustration, while other motherboards are more easily made to work under Windows 7, but at least there's an easy workaround in sight.

APC team

WINDOWS

WINDOWS UPDATE QUERY

When Windows Update schedules a reboot, what happens when it reaches that point? I know it logs me out and reboots, but does it return to where I left off? And will it update my PC if the computer happens to be asleep when that scheduled point is reached?

Stu Robertson

No, when Windows logs out, reboots and updates, it'll return you to the login screen. When you next log in, any programs you had running will have been shut down, so it's just like loading Windows from scratch. Another thing to beware of is if you had any open documents they'll have been closed and unsaved changes lost. If your PC is asleep when the scheduled moment arrives, then Windows will wake it to perform the update in the same way — again, don't put it to sleep without saving or closing documents first.

Cat Ellis

HARDWARE

LAPTOP GPU UPGRADE?

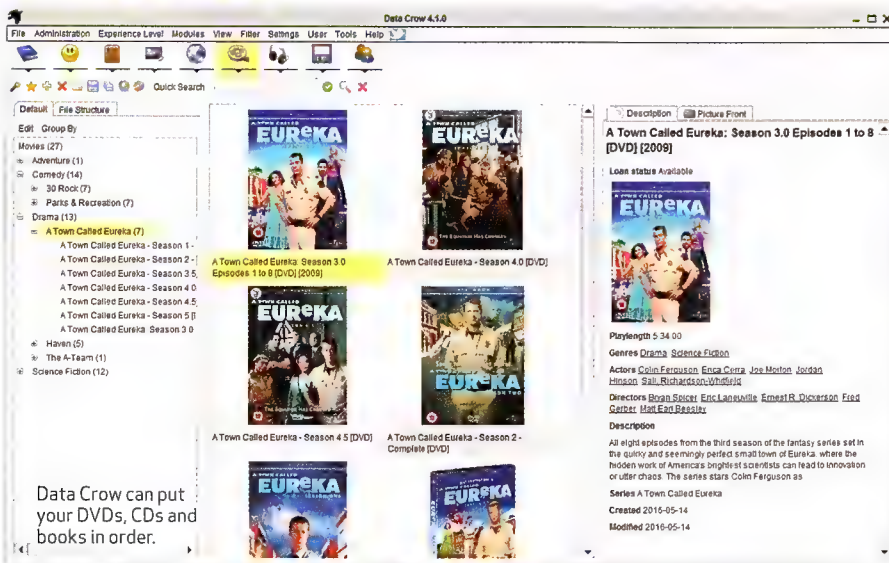
Greetings, I have an excellent 17-inch laptop, but its discrete graphics module seems to have died. It was a GeForce GTX 670M with 3GB GDDR5. I'm now running some games on the integrated Intel HD Graphics 4000 engine, but as you know, that's pretty slow. I'd like to replace the card, but I can't find a seller other than eBay. Is that the only option? Also, I don't need such a fast GPU for most of my games; what would you recommend for older engines, like the ones used in StarCraft and Diablo 3? The specs are: MSI GT70, Intel Core i7-3610QM, 17.3-inch 1,920 x 1,080 display, 16GB DDR3 RAM, 128GB SSD, 500GB hard drive.

Mike Abed

Based on the specs, that appears to be a 2012-era GT70. Unfortunately, MSI was



"If you're seeing a slow-down or stuttering of any sort, it's possible that's your bottleneck — particularly in *Battlefield*, which is more GPU-bound than *Call of Duty*."



not using replaceable modules back then, so your best bet for a working GPU is something scrapped from another laptop. eBay may indeed be your only hope.

These days, MSI has its GT72 and GT80 platforms, both built to accommodate upgrades. Several online vendors sell do-it-yourself kits that include an MXM graphics module, cooling solution, thermal compound and pads, and documentation. None of this helps you out of your current conundrum, but it's nice to know that some of today's gaming notebooks are more enthusiast-friendly.

APC team

NETWORKING BETTER PERFORMANCE WHEN GAMING ONLINE

I have a question about internet speed that's been bugging me. I play a lot of first-person shooters — mainly Battlefield and Call of Duty. I think I have a pretty decent system for those titles: an ASUS Maximus VII Hero, an Intel Core i7-4790K, 16GB of DDR3, a Samsung 750GB 840 EVO, and Windows 10 Professional. Here's the thing: I have a newer fibre internet connection. Is there a point where internet speed no longer factors into gaming performance? We don't (yet) do any video or audio streaming, so bandwidth shouldn't be a problem.

Steve Vanetti

A question similar to this came up a couple of months back, and it turned out that online gaming isn't very bandwidth-intensive at all. Although games vary in the amount of throughput they chew up, their demands are lighter than streaming audio, much less video. You didn't say anything about performance issues, but we noticed the missing graphics card mention. If you're seeing a slow-down or stuttering of any sort, it's possible that's your bottleneck — particularly in *Battlefield*, which is more GPU-bound than *Call of Duty*.

APC team

SOFTWARE A QUICK CATALOGUING PROGRAM QUERY

Do you know of a free program that's suitable for cataloguing and printing my DVD and CD collections?

Jim Duncan

Take a look at Data Crow (datacrow.net) — this is a free and open-source tool that provides you with all the tools you need to build both DVD and CD collections via its Movie and Music Album nodes. It requires Java, and be sure to right-click the installer and choose 'Run as Administrator' after downloading to ensure it's able to install itself to your Program Files directory.

The program takes a little bit of getting used to — the quickest way to use it is to enlist the help of built-in online services such as Amazon and IMDB. Simply enter search terms, then add any or all of the matching items (it's easy to build up entire TV series for example). Changes are saved automatically as you make them. You can analyse and organise your collection a number of ways, plus generate reports in a number of formats you can then print out.

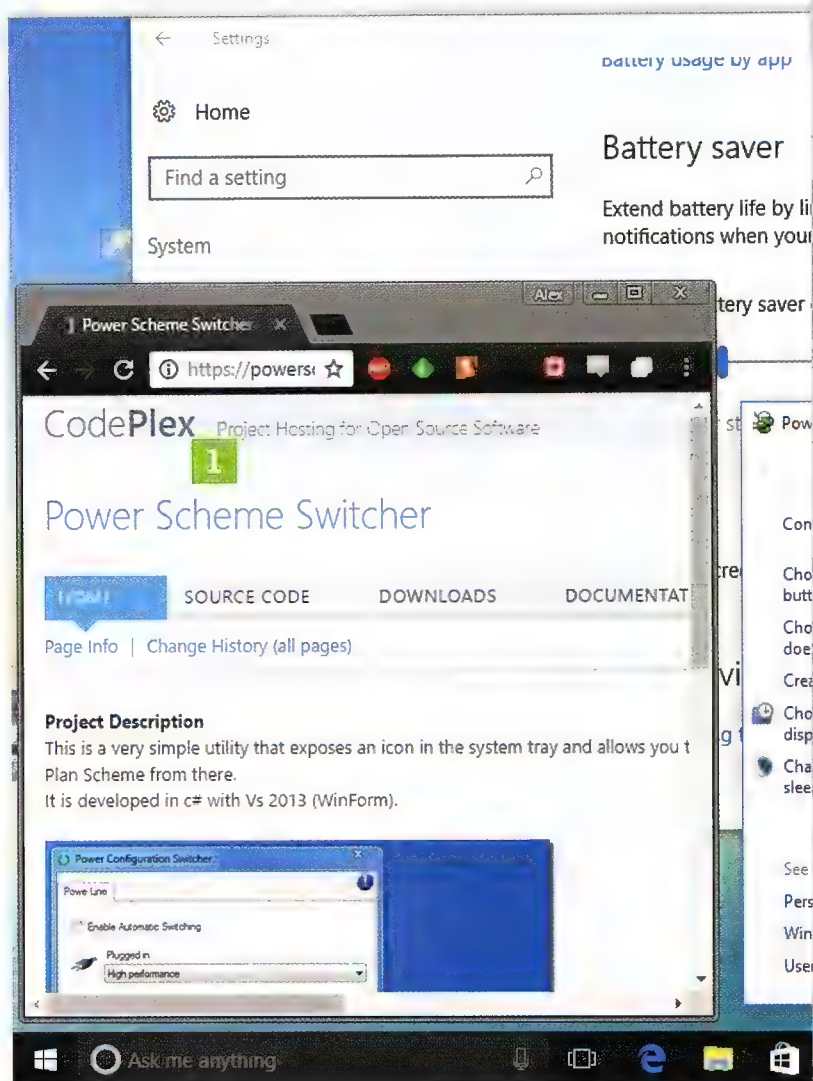
Nick Peers

Maximise Windows 10 battery life

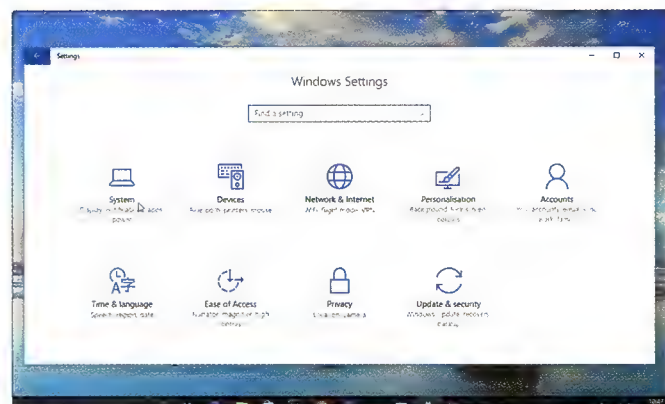
Control how Windows 10 manages power consumption and get more from your laptop's battery with Tim Hardwick.

Windows 10 runs well on all manner of portable devices partly because of its built-in energy-saving features. So whether you've upgraded your laptop to Microsoft's latest OS or got yourself a brand-new machine, you're going to want to make the most of them. In this tutorial, we'll show you how to set up Windows 10's power-saving functions to squeeze maximum life out of your laptop's battery.

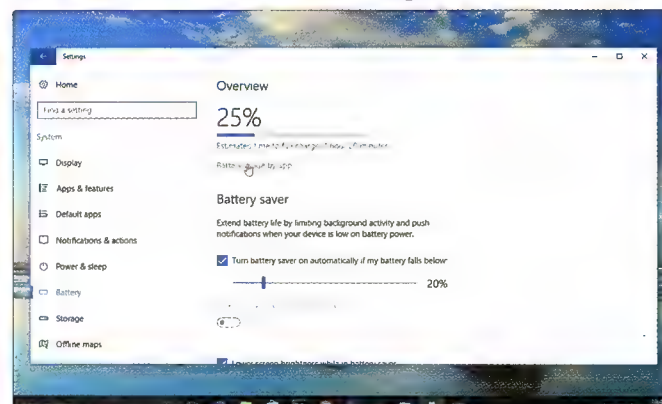
But first, it's worth familiarising yourself with Flight mode (or Airplane mode) — a quick way to turn off all wireless communications on your PC if you suddenly find your battery very low. Just select the Network icon on the task bar and choose 'Flight mode' to turn it on. And remember, by unplugging peripherals such as external hard drives and memory sticks when they're not in use, you can save even more power on the road.



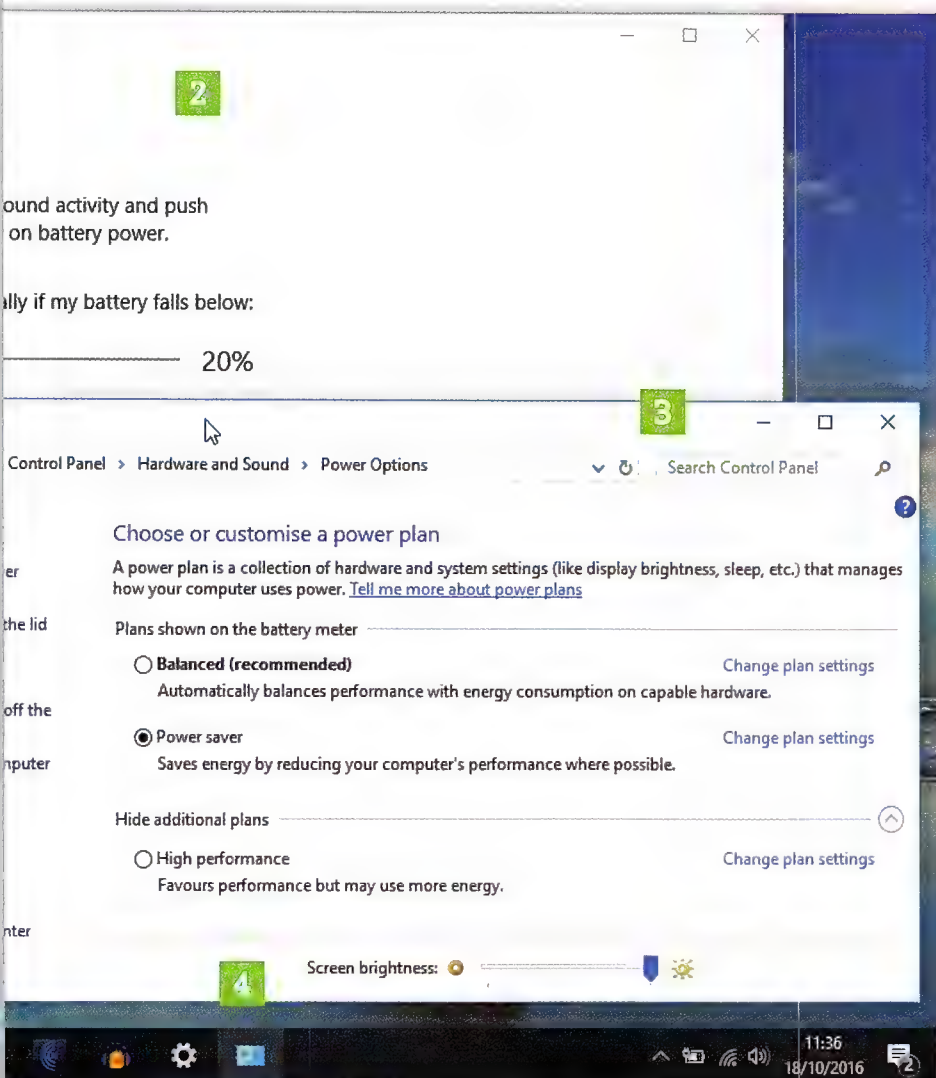
How to make your battery last longer



1 OPEN BATTERY SAVER
Battery Saver extends battery life by enabling you to limit background activity, and offers further access to different system settings and useful battery usage reports so you can identify your system's energy hogs. To access the feature, select 'Settings' from the Start menu, choose 'System' and then 'Battery' from the side column.



2 BATTERY SAVER OPTIONS
The Battery window is split into two — 'Overview' shows your current battery level and whether it's charging or draining, while 'Battery Saver' shows whether the feature is on or off, at what level the battery should be allowed to fall to before it is activated. Now, go ahead and select the 'Battery usage by app' option in the 'Overview' section.



1 DOWNLOAD POWERSWITCH
Install the Power Scheme Switcher tool and you can switch between battery Power plans according to your usage.

2 BATTERY SAVER
Adjust the Battery saver settings for when you're out and about.

3 POWER PLAN
Set up a power plan and you can manage how Windows uses power when your laptop isn't plugged in and charging.

4 DITCH APPS
Even minimised apps use up precious battery power, so be sure to only open apps you need and close all of the rest.

Jargon buster!

Airplane mode

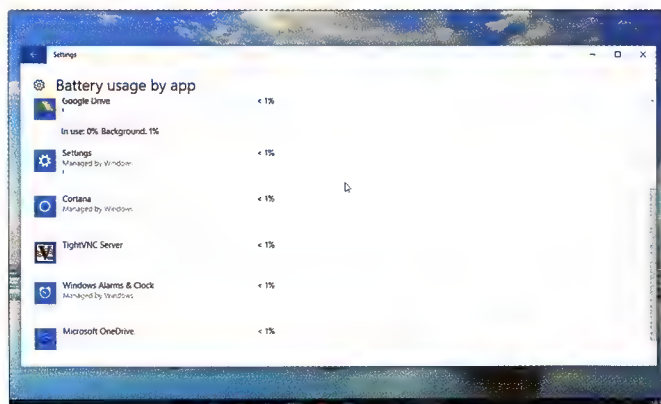
A quick way of turning off wireless communications on your PC. Some examples of wireless comms include Wi-Fi, mobile, Bluetooth, GPS and NFC (near-field communication).

Power plans

Pre-defined battery-saving profiles that can be customised for different usage scenarios.

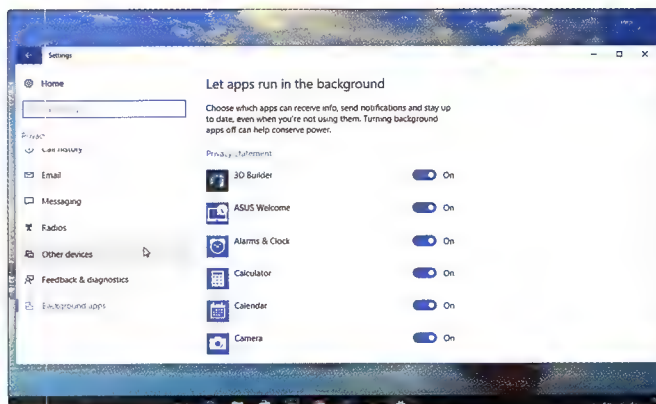
Power Scheme Switcher

A small free third-party tool for quickly switching between energy power plans.



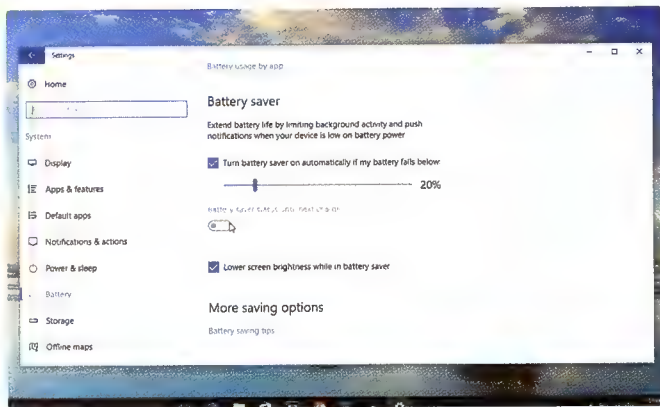
3 BATTERY USE

This window offers a breakdown of battery usage across recently-run apps, giving you an idea of what apps you should avoid using when you're not within easy reach of a power outlet. You can break the list down into Store apps or all installed apps, select a time period, or click individual apps to get a precise look at how much battery they've consumed.



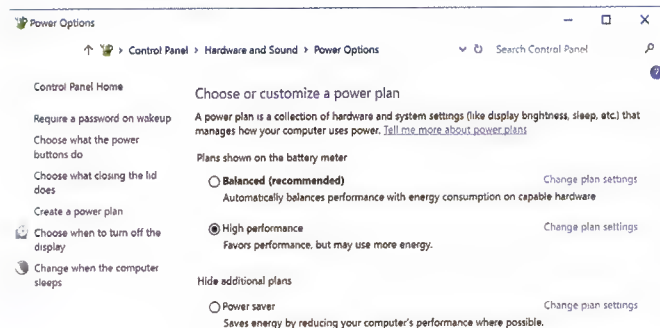
4 BACKGROUND APPS

Click the top-left arrow twice to return to the main Settings screen, then head to 'Privacy > Background apps'. From here, you can choose which apps can receive information, send notifications and stay up-to-date in the background when you're not using them. Turn off any non-essential items to conserve power.



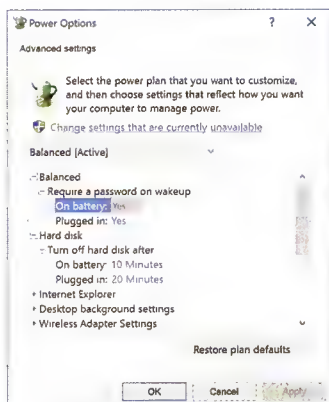
3 CUSTOMISE BATTERY SAVER

Head back to 'Settings > System > Battery'. From here, enable 'Battery Saver' and choose the battery level that triggers the feature. You can also choose whether to allow the screen brightness to be dimmed. Users of pre-Anniversary Edition Windows 10 can also click the plus button to 'Add an app' and exempt it from these settings and run as normal.



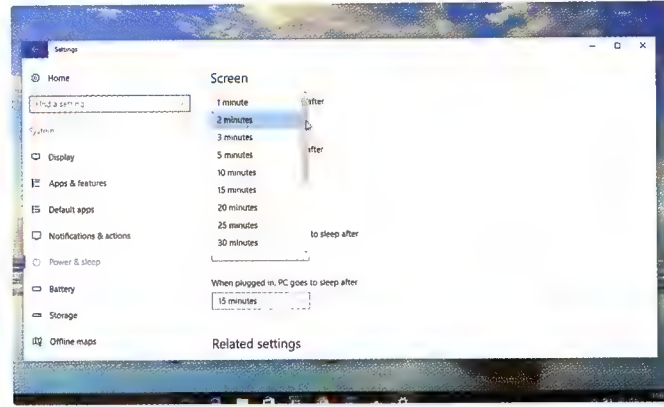
7 ADDITIONAL POWER SETTINGS

At the bottom of the 'Power & sleep' screen, under 'Related settings', you'll see a link to 'Additional power settings'. This opens the 'Power Options' panel which offers you more control over energy usage. A collection of defined hardware and system settings is called a 'power plan'. Select a pre-defined plan, tweak its settings, or create your own from scratch.



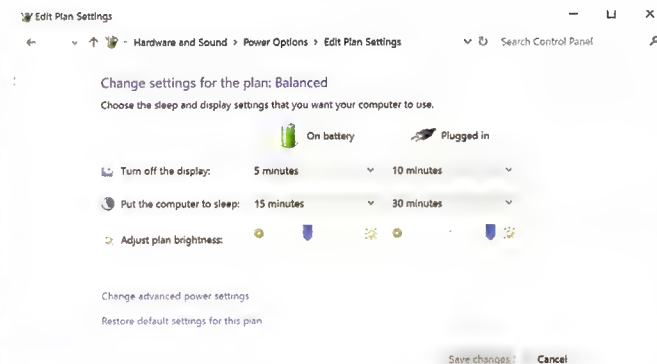
9 ADVANCED SETTINGS

Click the plus symbols to adjust options in the Advanced settings window. Choose 'Maximum Power Saving' mode in the dropdown menu, and set your hard disk to sleep when it's not in use. Pause the 'Slide show' in Desktop background settings and enable adaptive brightness. Finally, choose what Windows should do when power is all but depleted, under 'Critical battery action'.



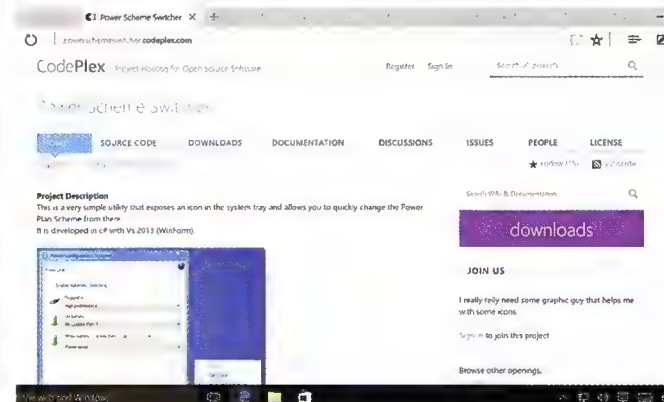
6 POWER & SLEEP

Now select 'Power & sleep' from the side column. Here you can quickly reduce the amount of time that your laptop sits idle before the screen automatically switches off — select the number of minutes from the dropdown menu under 'Screen'. The quicker it turns off, the more battery you'll save. Under 'Sleep', choose how long it takes before your PC naps.



8 PICK A POWER PLAN

Choose the pre-defined Power saver plan to eke out as much time from your battery as possible. To make the plan even more unforgiving, click 'Change plan settings' and under 'On battery', further reduce the time it takes before the display turns off and your PC goes to sleep. For more control, click 'Change advanced battery settings' to adjust other system behaviours.



10 FINAL STEPS

Once you've applied power plan settings, you're all set. To activate power-saving mode, click the battery icon in Windows' desktop notifications bar and hit the 'Battery saving' tile. If you have more than one plan for different usage scenarios and want to switch between them from the desktop on the fly, download and install Power Scheme Switcher from goo.gl/4rf4ZX.

18th Nov - 31st Dec, 2016

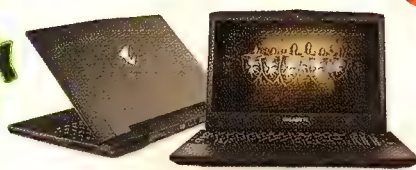
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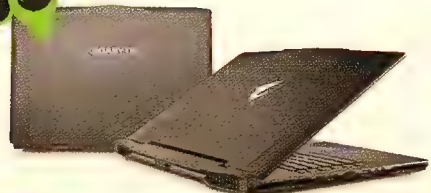


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Master iOS 10's Control Centre

Learn about the iPhone and iPad shortcuts that are only ever a swipe (or three) away with Alan Stonebridge.

Control Centre saves you the bother of digging around for often-used device settings, opening an app that's playing audio to control its playback, or searching for a flashlight app to light your path. Whether you're at the Home screen, in an app, or you've just woken your device to its Lock screen, you can do all these things and more.

To open Control Centre, swipe upwards from the screen's bottom edge. This slides a card over the bottom part of the screen and dims the rest of the display. Swiping up while using an app might not reveal Control Centre right away, though; look for a small tab with an arrow on it at the centre of the screen's bottom edge; the point of this is to stop you

accidentally pulling Control Centre over an app just by interacting with its controls near that point. Tap elsewhere on the screen to dismiss the tab and carry on, or swipe upwards from it to pull Control Centre into view.

From left to right, the top row of Control Centre contains buttons that toggle Airplane Mode (which disables Wi-Fi and Bluetooth), enable or disable Wi-Fi or Bluetooth on their own, toggle Do Not Disturb to avoid calls and notifications interrupting you, and lock the screen orientation (to portrait only on iPhone or iPod touch, but also to landscape on iPad).

Below these is a slider that controls screen brightness, illuminating the rest of the display

as normal so you can accurately see its effect.

Next down are buttons to mirror your iOS device's screen to an Apple TV and control whether Macs and other iOS devices can see your device and send things to you over a direct Wi-Fi connection between devices.

The Night Shift button toggles that feature and shows when it'll next turn on or off. Night Shift warms the screen's output, reducing the blue light that can disrupt your sleep. Set up Night Shift in 'Settings > Display & Brightness'.

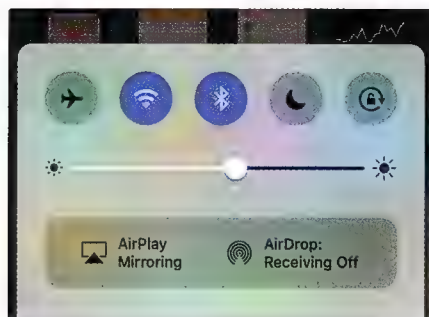
ED TOUCH ENHANCEMENTS

The bottom row contains buttons that turn an iPhone's flash into a flashlight or open the Clock, Calculator or Camera app. On a device with 3D Touch, press firmly on them for extra options, such as flashlight intensities, preset timer durations and camera modes.

Note the page dots that are shown below the card, which are new in iOS 10 – read on to learn how Control Centre's layout has changed and about its new options.

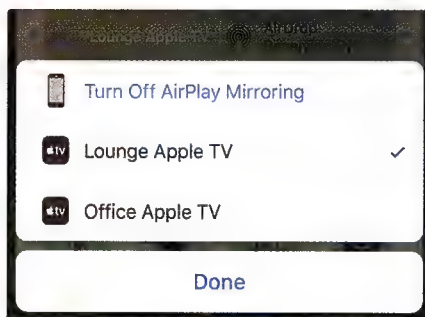
"Night Shift warms the screen's output, reducing the blue light that can disrupt your sleep."

Control your iOS device's key features



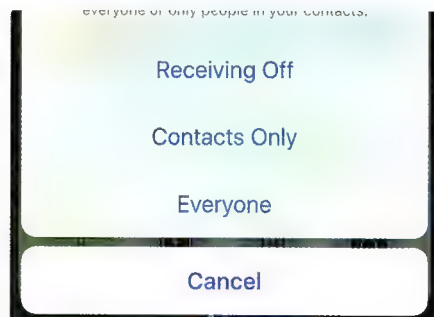
1 OPEN CONTROL CENTRE

Swipe up from the bottom edge of the screen; the last card used is shown even after locking your device. On the first card, the top row's icons and Night Shift toggle their feature when tapped. AirPlay and AirDrop offer some choices, though.



2 STREAM TO APPLE TV

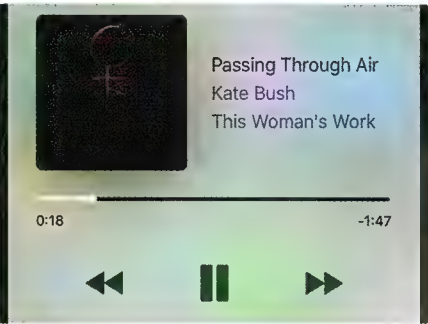
To mirror your device's screen to a television, tap AirPlay Mirroring and then tap the name of a (second-generation or newer) Apple TV that's been found on the same network. Tap AirPlay Mirroring again for an option to turn this off.



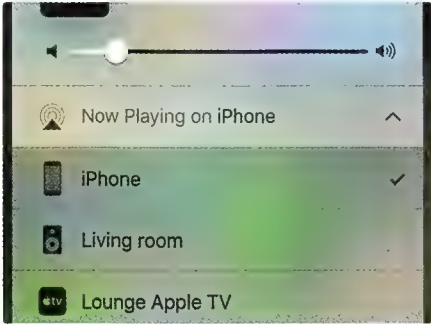
3 RECEIVE FROM A DEVICE

Tap AirDrop and then 'Contacts Only' or 'Everyone' to send things to or receive from a Mac or iOS device that's nearby. AirDrop to and from Macs only works with models made in the last few years (see apple.co/2eA1elc for a list of them).

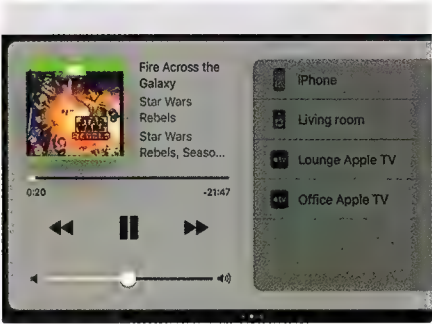
Control audio from the Now Playing card >



1 TAKE CONTROL OF MUSIC
When an app is playing audio in the background, Control Centre's second card shows details (tap them to go to the app), playback controls, plus headphones, Bluetooth speakers and AirPlay speakers you can send the audio to (one at a time).

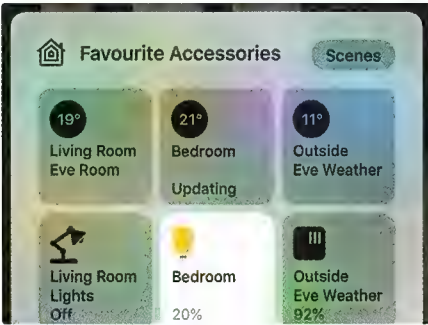


2 PICK A TARGET ON IPHONE
On iPhone, the current destination for audio is shown in the bottom row of the card. Tap it to expand it and see the list of available speakers. Tap one to send audio to it, then tap outside of Control Centre or swipe down on it to close it.

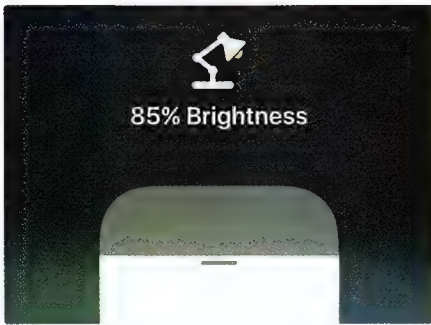


3 SPLIT VIDEO AND AUDIO
You should also use the second card if you want to watch video on your device yet send its audio to a better speaker; ignore the first card's AirPlay control in this instance, as it always sends video and audio to your specified destination.

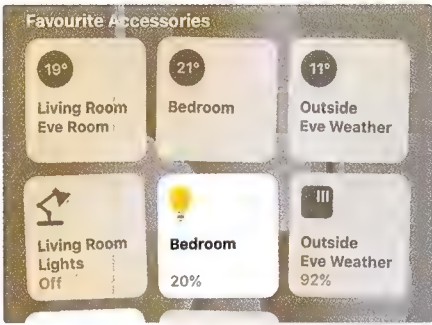
Control HomeKit accessories and scenes



1 MASTER OF YOUR HOME
If you've configured accessories in the Home app, such as lights, door locks or air quality sensors, Control Centre's third card shows up to nine accessories (12 on iPad) and scenes marked as favourites, for at-a-glance info about their status.



2 ACCESSORY INFORMATION
Tap an accessory (that isn't just a sensor) or a scene to toggle its status — to turn a light on or off, for example. If an accessory allows finer adjustment, such as a light's brightness, apply 3D Touch/hold a finger on it to show that control.



3 CHOOSE YOUR FAVOURITES
Tap the house icon (top left) to open the Home app if you need to use its extra controls or want to change or rearrange the favourite accessories that are shown in Control Centre: tap 'Edit', then drag the accessories into your desired positions.

ALLOW ACCESS WHEN LOCKED:

Today View

Notifications View

Siri

Reply with Message

Home Control

Wallet



Consider your security

Choose which features are accessible while locked.

You may be happy for all of Control Centre to be available at the Lock screen on an iPad that stays at home, but want to prevent remote access to your HomeKit accessories by anyone who picks up your iPhone. You can entirely block access to Control Centre at the Lock screen (and, separately, in apps if you find that you accidentally open it while using them) in 'Settings > Control Centre'. To disable control of HomeKit accessories at the Lock screen — using Control Centre or Siri voice control — turn off Home Control in 'Settings > Touch ID & Passcode'.

Work better across multiple Apple devices

Alan Stonebridge shows how to smooth your cross-platform experience with Apple's Continuity features.

Continuity is a group of six features that are available in the latest versions of iOS and macOS, and which provide extra convenience in certain scenarios. Two of these features – Auto Unlock and Universal Clipboard – are new in the latest versions of Apple's operating systems.

With the former of those switched on, when you wake your Mac, it checks for your Apple Watch nearby, and that the Watch is unlocked; if so, your Mac assumes it was you who woke it and skips its usual request for your password, taking you straight to your desktop.

Universal Clipboard recognises that you may in fact be using more than one of your devices at the same time, and so its purpose is to enable you to copy and paste text, images or video from one device to another just by using the Clipboard as you normally would.

OTHER CONTINUITY FEATURES

The remaining four Handoff features were added to Apple's operating

systems some time ago. However, if you've been using a Mac that predates 2012 until recently, you won't have had the luxury of enjoying these features (not without messing around with your system, anyway). That's because Continuity features require a Mac with Bluetooth 4.0, and even then, not all models are officially compatible with it.

Handoff provides the ability to move a task, such as composing a message, working on a spreadsheet or reading a web page, from one device to another in one quick step.

Then there are Continuity's mobile phone-related features; making and receiving phone calls and sending and receiving SMS and MMS messages from your Mac or other iOS devices when your iPhone is nearby.

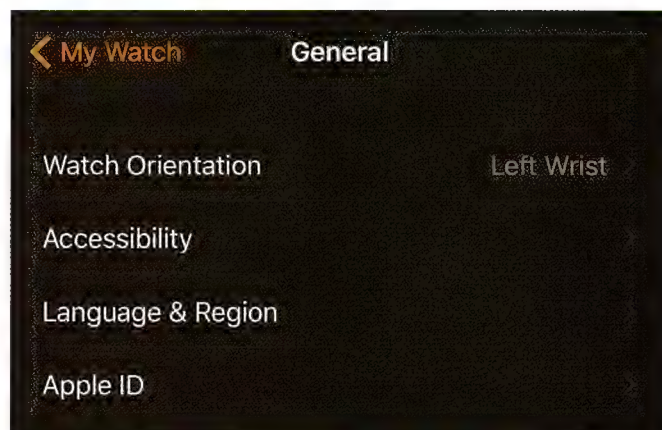
If your call plan permits tethering, Instant Hotspot gets your other devices online by piggybacking on its mobile data connection. Your non-Apple devices can connect to the Wi-Fi hotspot broadcast by your iPhone too. (The network's password is shown in Settings.)

All of the Continuity features require your participating devices to be signed in to your iCloud account, as proof of your identity. Most features also need Bluetooth and Wi-Fi to be turned on, though not all need your devices to be on the same network; Handoff and relaying phone calls do, Universal Clipboard doesn't.

Read on to learn how to make it more convenient than ever to use your devices together.

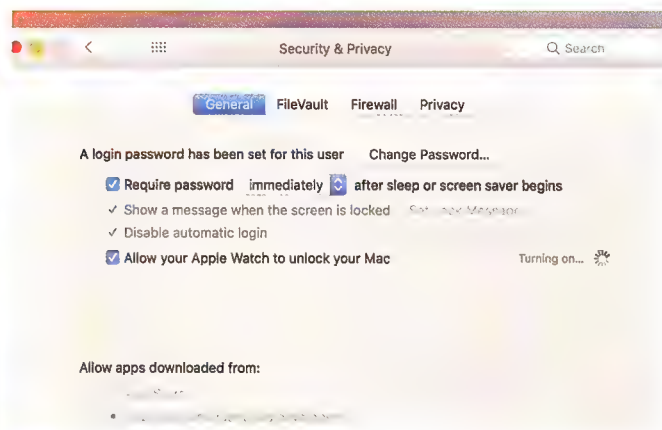
"All Continuity features need participating devices to be signed in to the same iCloud account."

How to Use Continuity



1 START SETTING UP AUTO UNLOCK

Ensure your Mac's Bluetooth and Wi-Fi are on, then that your Mac and Watch are signed in to iCloud with the same Apple ID (go to ' > System Prefs > iCloud' on your Mac, and in the Watch app on your phone, go to 'General > Apple ID').



2 MORE AUTO UNLOCK SETTINGS

If you haven't already, set up a passcode in the Watch app on your iPhone, head to 'Passcode'. In ' > System Prefs > Security & Privacy' on your Mac, enable 'Allow your Apple Watch to unlock...' and wait for the feature to activate.

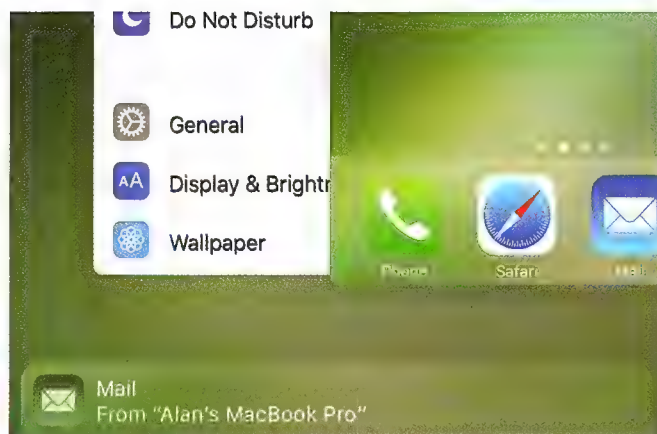
Web browser: Safari

Ask to keep changes when closing documents
Close windows when quitting an app
When selected, open documents and windows will not be restored when you re-open an app.

Recent items: 10 Documents, Apps, and Servers

☒ Allow Handoff between this Mac and your iCloud devices

☒ Use LCD font smoothing when available



3 SET UP HANDOFF

To use Handoff, a Mac's Wi-Fi must be turned on, even if it's using Ethernet for networking. On your Mac, go to 'System Prefs > General' and turn on 'Allow Handoff between this Mac and your iCloud devices'.

4 SWITCH DEVICES FOR A TASK

Enable it on iOS in 'Settings > General > Handoff'. To move a task from iOS to Mac, click the Dock icon left of the Finder icon. Another way to do this is to swipe up from the app icon on the Lock screen, or double-click Home and tap the banner.

< Mobile Data Personal Hotspot

Personal Hotspot



Now Discoverable.

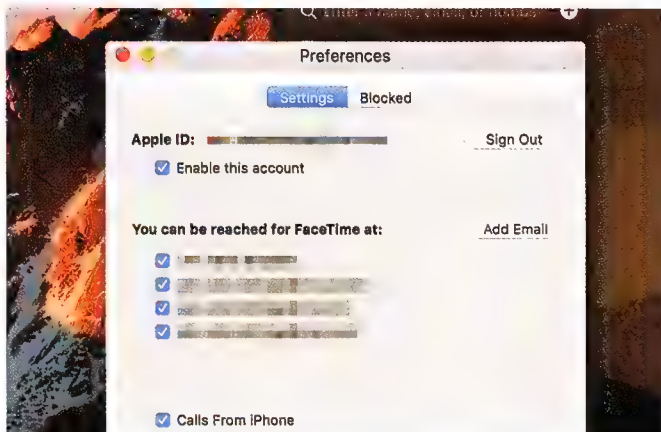
Other users can look for your shared network using Wi-Fi and Bluetooth under the name "iPhone".

Wi-Fi Password

1tr8c2oh942pk

5 SET UP INSTANT HOTSPOT

On your iPhone, go to 'Settings > Mobile Data' and turn on the Personal Hotspot feature. From the Wi-Fi icon on your Mac, choose the name of your iPhone. On another iOS device, tap your iPhone's name in 'Settings > Wi-Fi'.



7 CHOOSE DEVICES FOR CALLS

Pick devices on which to make and receive calls. Turn on 'Calls From iPhone' in FaceTime's prefs on your Mac, and in 'Settings > FaceTime on other iOS devices'. Incoming calls show as a notification on a Mac and a call screen on iOS.

< Phone Calls on Other Devices

Allow Calls on Other Devices



Use your iPhone mobile account to make and receive calls on devices signed in to your iCloud account when they are nearby and on Wi-Fi.

ALLOW CALLS ON

Deeper Understanding (iPad)



6 PHONE CALLS ON ALL DEVICES

Sign in to FaceTime on each device using the Apple ID you use for iCloud. Ensure your iPhone and other devices are on the same network. In 'Settings > Phone > Calls on Other Devices' on the iPhone, enable 'Allow Calls on...'.

< Messages Text Message Forwarding

Allow these devices to send and receive text messages from this iPhone.

Deeper Understanding (iPad)



MacBook Pro (Mac)



8 SMS AND MMS, EVERYWHERE

Your iMessage account in Messages' prefs (Mac) and Apple ID in 'Settings > Messages > Send & Receive' (iOS) must match. In iPhone's 'Settings > Messages > Text Message Forwarding', enable devices and then enter the code they receive. ■

Write Bash scripts in Linux

Alexander Tolstoy shows you how to get creative, flip the script and have a bash at writing your very own Bash scripts... What? What did I say?

For many Linux users, a command-line interface is still something that's best to be avoided. Why drop to the command-line shell when virtually all activities can be performed perfectly well in a graphical desktop environment, after all? Well, it depends. While modern Linux distributions (distros) are very user-friendly and, in many areas, outperform Windows and macOS, there's a huge amount of power hidden away in Bash (Bourne Again Shell). The shell is a cornerstone of the GNU Project and has been with us since 1989. It's also been a standard Unix shell in many operating systems (not just Linux) and there's no reason to think it will lose its importance in the future.

The reality is that there are many command-line applications that can replace their desktop analogues. It means that, from a pragmatic point of view, graphical applications introduce huge system resource overheads, when you could instead enjoy robustness, speed and efficiency. Learning Bash scripting can help you understand how many Linux commands work and also help you automate certain routines. There's no better way to approach programming than Bash scripting. The barrier is low, the possibilities are endless — so it's time for the real deal!

We'll start with basics and create a small but useful script. A script is a text file with (roughly) a sequence of commands and few other special attributes. The first is the obligatory first line, which should look like `#!/bin/bash`, where `#!` is a magic number (a special marker that designates that this is a script) and `/bin/bash` is the full path to command interpreter. The second attribute is specific for filesystems used in Unix and Linux: in order to tell Bash that our file is a script (not just a plain text file), we have to make it executable:

```
chmod +x script.sh
```

Using the `.sh` extension is optional, as Bash looks for that 'executable bit' and tolerates any extension. So the simplest structure of our test **script.sh** will be like this:

```
#!/bin/bash
command_1
```

```
command_2
...
```

You can replace our placeholders with something working and useful. Say, we want to clean up temporary files in Linux:

```
#!/bin/bash
cd /var/tmp
rm -rf *
```

This way, you can put any commands in your scripts, line by line, and each command will be executed consequently after a previous one.

Before we move forward, let's pay some attention to special characters, i.e. characters that aren't executed and treated differently by Bash. The first one is `#`, which enables you to put a random comment after it. There's no need for any 'closing tag', just put `#` and whatever follows will be treated as a comment until the end of the line. The second useful special character is a semicolon (`;`), which separates one command from another within the same line. You can use it like this:

```
#!/bin/bash
cd /home/user; ln -s Images
Pictures; cd Pictures; ls -l
```

The practical use of `;` assumes that you can save some vertical space by combining similar or related commands in one line, which helps keep things tidy. Another helpful hack is to use dots (`.`). Not only do they indicate full stops, but in Bash, dots introduce special logic. A single dot means 'current directory', while two dots make Bash move you one level up. You may not know beforehand where a user will place your script, so the `cd .` sequence will move Bash to the current directory, whatever it is. Similarly, `cd ..` will bring you to the parent directory.



There are also other special characters, such as `*` which is wildcard for 'anything', backslash (`\`) for quoting the following character, exclamation mark (`!`), which reverts the command after it and many more. Luckily, in many cases special characters are self-explanatory thanks to the context.

VARIABLES

A variable is a word or any sequence of allowed characters that can be assigned to a value. You can use a calculation result or a command output, or anything you want as a value for variable and use way more comfortably than in a direct way. In Bash, the name of a variable is a placeholder for its value, so when you are referencing a variable by name, you are actually referencing its value. Assigning a value to a variable is done via the equals sign (`=`), while referencing is done using the dollar sign (`$`) followed by the variable name. Let's have a look:

Tips, tricks and timesavers

The more time you spend in Bash, the more you may feel that some aspects of it could have been much better optimised. However, this isn't entirely true. Bash has been used in system administration for 27 years, and it can be excellent when it comes to optimisation as long as you're willing to put in a little effort to make it your own. Remember that Bash stores its settings in the `~/.bashrc` file (individually for each user), which you can populate with your own features. Let's start by automating `mkdir` `$dir` and `cd` `$dir` with a single command. Add the following to `.bashrc`:

```
mkcd()  
{ mkdir $1; cd $1; }
```

And then don't forget to run `$ source .bashrc` to apply changes. After that when you run, say, `$ mkcd build` you will immediately enter the newly created build directory. For easier navigation, you might want to add bookmarks for

frequently used directories. Use the `CDPATH` function in `.bashrc` for that:

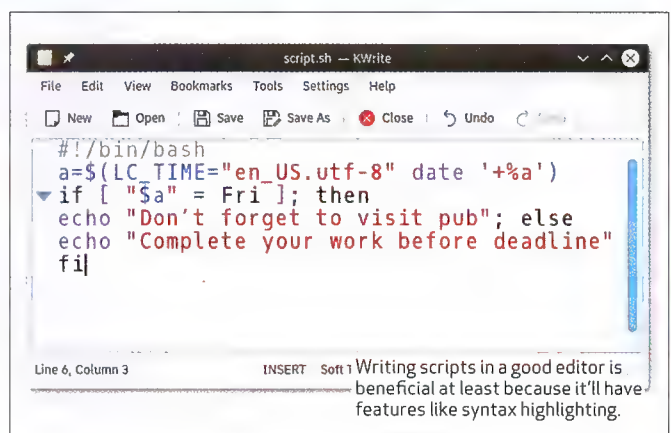
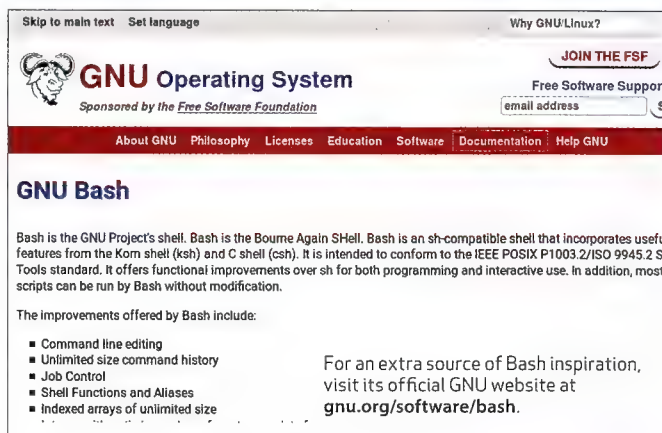
```
$ echo CDPATH=/home/user/Documents/  
subscriptions/LXF >> ~/.bashrc && source  
~/.bashrc
```

Once done, try using `$ cd LXF` from anywhere in your system and you'll be taken to the right place. `CDPATH` uses the last element in the path for the bookmark name.

Finally, the easiest and quickest way to save some time is to populate your `.bashrc` file with command aliases. You can assign an alias to a long command that's tiresome to type, or simply because you don't want to mix habits from another OS. Let's add a couple of DOS commands as an example:

```
alias dir='ls -l'; alias del='rm -rf'
```

This way, you can create a custom-tailored Bash that will work lightning-fast!



```
#!/bin/bash  
a=175  
var2=$a  
echo $var2
```

In this example, we first assign a numeric value to variable `a`, then assign its value to another variable `var2` and then print the value of the latter (`175`). You can use a text string as a value and, in case there is at least one space or punctuation mark, you'll need to put a string in quotes:

```
a="Mary had a little lamb"  
echo $a
```

It is also permissible to declare several variables in one line.

```
a=Mary b=had c="a little"  
d=lamb
```

```
echo $a $b $c $d
```

Sometimes, you'll need to assign a command output to your variable. There are two ways to do it. In the following example, each line produces the same result:

```
a=$(df --total)  
b='df --total'  
echo $a $b
```

The output of `$b` will only work if using exactly the correct type of single quotes (`' '`).

CONDITIONALS

Bash supports traditional Unix constructions for conducting tests and changing the behaviour of a script depending on given conditions. There are two basic things that you're advised to remember: the 'if/then/else' tree allows a command to be executed when a condition is met (or not), whereas 'while/do/else' is a tool for looping parts of a script, so that some commands will be executed all over again until certain a condition is met. It is always best to illustrate this theoretical part with some working examples. The first one compares the values of two variables and if they match, the script prints the happy message:

```
a=7  
b=8  
if [ "$a" = "$b" ]; then  
echo "Yes, they match!"  
else  
echo "Oh no, they don't..."  
fi
```

Please take note that once you introduce 'if', don't forget to put 'fi' in the end of your construction. Now it seems that we've reached a point at which we can make some use of our script. Let's check the day of the week

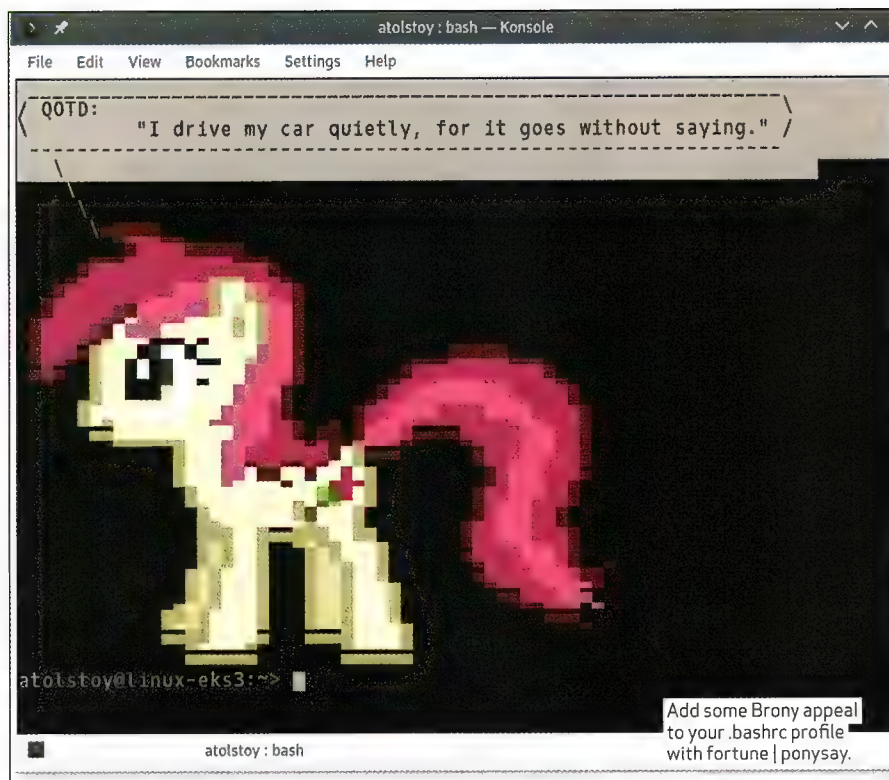
and, once it's Friday, print a reminder:

```
#!/bin/bash  
a=$(LC_TIME="en_US.utf-8"  
date +%a)  
if [ "$a" = Fri ]; then  
echo "Don't forget to visit  
pub"; else  
echo "Complete your work  
before deadline"  
fi
```

Notice that we included the extra declaration of the `LC_TIME` variable for the sake of compatibility. If we didn't, then our script wouldn't work on Linux systems with non-English locale. However, let's advance a little further and see how we can use the while/do method. This script runs in the background and clean the temporary directory every hour:

```
#!/bin/bash  
a='date +%H'  
while [ $a -ne "00" ]; do  
rm -rf /var/tmp/*  
sleep 3600  
a='date +%H'  
done
```

You may notice that this script will stop working at midnight, because the condition while hour not equals 00



Quick tips

- There are always things that can be optimised, like avoiding excessive variable declaration. The following example:

```
color1='Blue'
color2='Red'
echo $color1
echo $color2
```

...can be easily shortened to:

```
colors=('Blue' 'Red')
echo ${colors[0]}
echo ${colors[1]}
```
- Some words and characters in Bash are reserved and cannot be used as names for variables: **do**, **done**, **case**, **select**, **then** and many more. Also avoid whitespaces and hyphens, though underscores are allowed.
- To make your code readable, use indents, especially for nested elements. Also commenting parts of your script after a # sign is a good practice.

stated above, will be unmet once the day is over. Let's improve the script and make it work forever:

```
#!/bin/bash
while true; do
a='date +%H'
if $a -eq "00"; then sleep
3600
else
while [ $a -ne "00" ]; do
rm -rf /var/tmp/*
sleep 3600
done
fi
done
```

Pay attention to how you can check conditions using **if** and **while** if your variable contains an integer number, you can use

alternative operators, such as **-eq**, **-ne**, **-gt** or **-lt** as 'equal', 'not equal', 'greater than' and 'less than' respectively. When you use text strings, the above substitution will not work and you'll need to use **=** or **!=** instead. Also, the **while true** construction means that our script will not exit until you manually interrupt it (Ctrl-C or by killing) and will continue running in the background. Both **if** and **while** can be put in cascades, which is called 'nesting' in Bash. Just don't forget to put the proper number of **fi** and **done** elements at the end to make your script work.

SIMPLE LOOPS

Using conditions may be a brilliant way to control your script's behaviour, but

there are other use cases when you need to optimise your routines with Bash, say, for recurring actions with variable data, such as when you need to run one command several times with different arguments. Doing it manually can be unacceptable for many reasons, so let's try to solve the problem gracefully using the **for** loop. In the following example, we shall create several resized versions of the original image **rose.png** using the convert tool from ImageMagick:

```
#!/bin/bash
for a in 10 25 50 75 90
do
convert rose.png -resize
"$a"% rose_resized_by_"$a"_
percent.png
done
```

Real-world one liners

You can make practically any Bash script a one-liner, even though it would be hard to read it. But there are a lot of useful yet short Bash scripts created by the people from around the world. Even if you feel like you don't need any more practice at writing scripts, looking at other's best practices will not hurt. A one-liner means that you can use it directly as a command.

The first example script we're going to show off is for music lovers, and it converts all FLAC files that it finds in the current directory to MP3 files at a good quality setting (320kbps) using FFmpeg.

```
# for FILE in *.flac; do ffmpeg -i "$FILE"
-b:a 320k "${FILE%.flac}/mp3"; done;
```

Another tip is to copy something to the X.org clipboard from the command line. First make sure you have the xclip package

installed, then try the following:

```
# xclip -in -selection c script.sh # or
# echo "hi" | xclip -selection clipboard
```

The first command will copy the contents of your script to the clipboard, while the second one will put the word 'hi' there.

The next examples shows 10 large files opened by currently running processes in your system:

```
# lsof / | awk '{ if($7 > 1048576) print
$7/1048576 "MB" " " $9 " " $1 }' | sort -n -u
| tail
```

It's extremely useful when you need to identify the origin of the high load and standard system monitor doesn't clear things up. You have to be root to run this command.


```

atolstoy@linux-eks3:~> bash --help
GNU bash, version 4.2.47(1)-release-(x86_64-suse-l
inux-gnu)
Usage: bash [GNU long option] [option] ...
       bash [GNU long option] [option] script-fil
e ...
GNU long options:
  --debug
  --debugger
  --dump-po-strings
  --dump-strings
  --help
  --init-file
  --login
  --noediting
  --noprofile
  --norc
  --posix
  --protected
  --rcfile
  --restricted

```

Bash itself has a number of startup options. Explore them via `$ bash --help`.

The example above declares `a` as an integer and lists all its values. The number of times the `convert` command will run matches the number of values. Sometimes, you need a longer list of values, so let's optimise our script using start/stop values and a step:

```

#!/bin/bash
for a in {10..90..5}
do
  convert rose.png -resize
"$a"% rose_resized_by_"$a"_
percent.png
done

```

The syntax used can be simply described as `{start..end..step}` and allows you to build plain arithmetical progressions. There are also a couple of alternative ways to do the same thing. First, let's use GNU `seq`, which is shipped with all Linux distros:

```

for a in $(seq 10 5 90)
As the line suggests, we're using it as
$(start $step $end). Second, we can
write the loop conditions in this way:
for (( a=10; a<=90; a+=5 ))
  +=5 increments the value of $a
by five. If we wanted to increment by 1,
we'd use ++. Looping is also a very
quick way to number elements using
variable incrementing. See below
where we list the days of the week:
#!/bin/bash
a=1; for day in Mon Tue Wed

```

```

Thu Fri
do echo "Weekday $((a++)) :
$day"; done

```

This script will return the list with numbered days (Weekday 1: Mon; Weekday 2: Tue and so on).

SOME ADVANCED TIPS

We already know how to put commands in scripts and how to add arguments to certain commands. But Bash can do a lot more — it provides a way to pass a multiline text string to a command, a variable or even to a file. Within the Bash terminology, it's called the 'heredoc' format. To illustrate it, let's create another script from our script:

```

#!/bin/bash
cat <<EOF > print.sh
#!/bin/bash
echo "I'm another script"
EOF

```

The construction `<<EOF...; EOF` lets you wrap almost anything into one logical object that you can manipulate in the same way you do a variable's value, like you can assign the data selected from a DB to your variable:

```

$ sql=$(cat <<EOF
SELECT foo, bar FROM db
WHERE foo='baz'
EOF;)

```

Earlier, we used a script to downsize an image by a given percentage. However, what if we needed to define that percentage by hand? Let's use script variables that accept arguments when the script is run:

```

$ cat script.sh
#!/bin/bash
a=$1
convert rose.png -resize
"$a"% rose_resized_by_"$a"_
percent.png

```

When you run the script and give the desired percentage as an argument (`$ ./script.sh 50`), your image will be resized by the given value (50%). However, if you run the script without any argument (`$ ./script.sh`), it will create an unchanged copy of `rose.png` under another name. To fix this, we need to check if the variable has non-null/non-zero string, using the `-n` key:

```

#!/bin/bash
a=$1
if [ -n "$1" ]; then
  convert rose.png -resize
"$a"% rose_resized_by_"$a"_
percent.png
else exit; fi

```

There's so much more you can do with Bash, but we hope that these basics will encourage you to dive into this powerful command-line system. ■

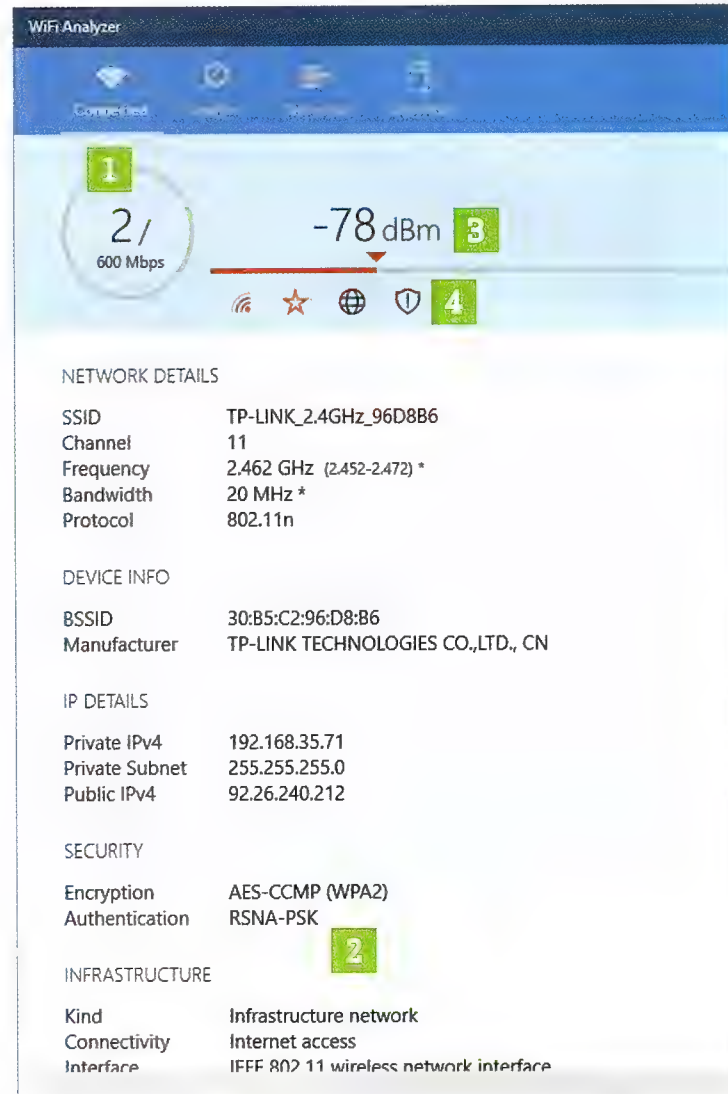
Analyse and speed up your Wi-Fi

Nick Peers shows how to improve your Wi-Fi network's performance by reducing interference and congestion.

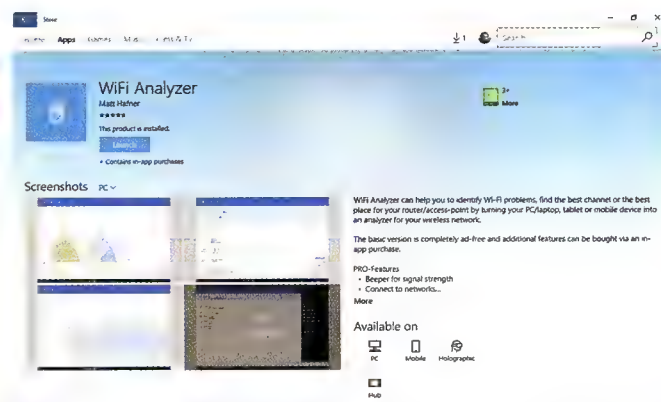
Today's Wi-Fi networks are more powerful than ever, but you can still encounter problems at the edges of your network's range, where 'dead spots' see a weak or non-existent signal. This might be down to the placement of your router, but it can also be caused by interference from other networks where they overlap.

Most network interference occurs when competing networks are transmitting on the same channel. If you know who's transmitting on which channel, you may be able to improve matters by switching your own network to a less congested one.

In this tutorial, we'll show you how to use a free app called WiFi Analyzer to not only measure your own network's signal strength at various points in your home, but also analyse which channels are being overused, enabling you to find your own sweet spot among all that competition.

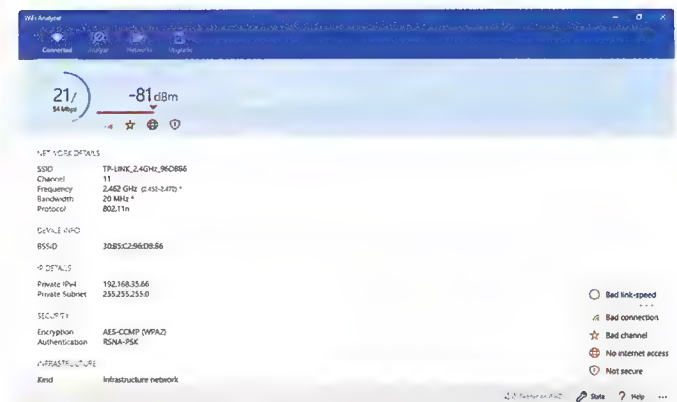


How to avoid interference on your network



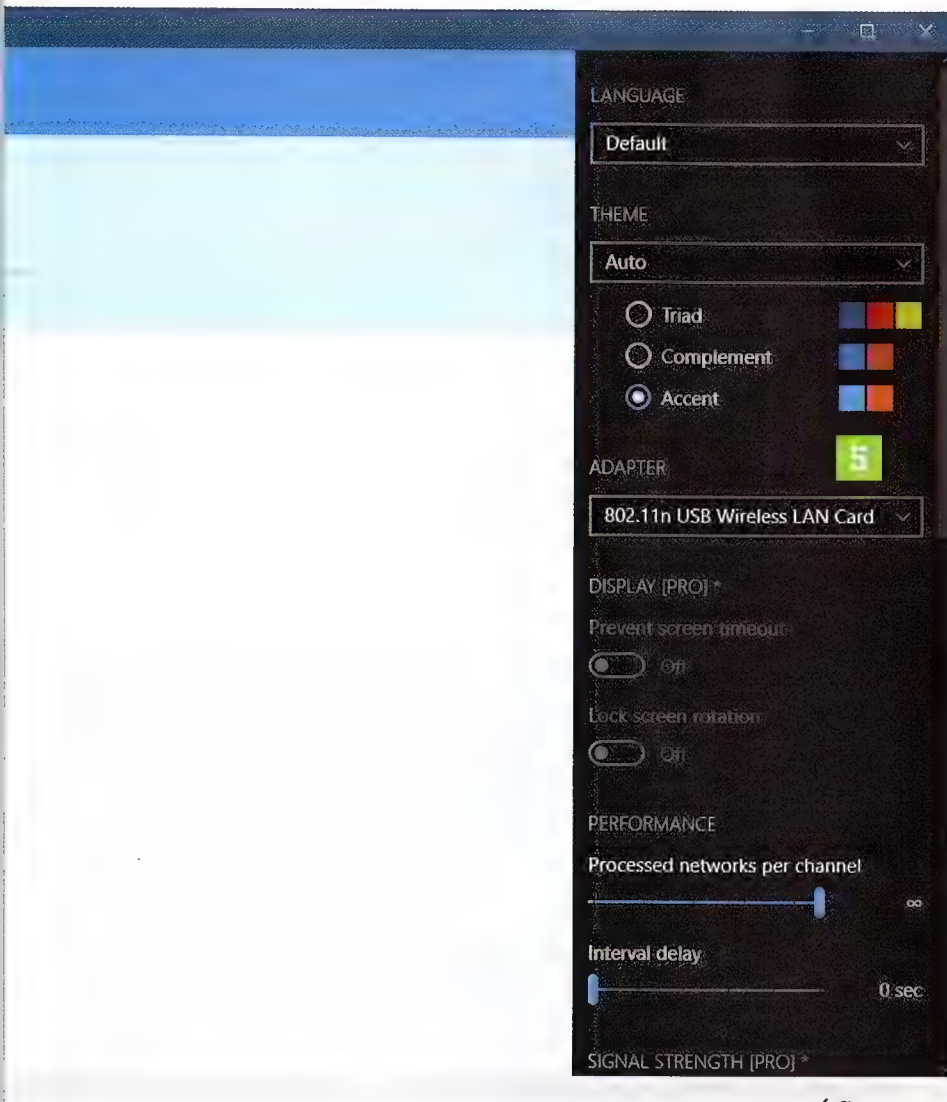
1 GET WIFI ANALYZER

Open the Microsoft Store and search for 'WiFi Analyzer' — don't confuse it with WiFi Analyzer Tool, so verify it's published by Matt Hafner before clicking the Install button. Once downloaded and installed, click the Launch or Open button to get started with using it. You'll first be prompted to select your location — choose 'Australia' and click or tap Close.



2 REVIEW CURRENT NETWORK SETTINGS

WiFi Analyzer will first check your local network settings, which it'll display under the 'Connected' section. It basically gives you an indication of your network's strength and whether or not there are other networks interfering with your signal. The annotated screenshot above provides a more detailed explanation of what to look for on this screen.



1 SIGNAL STRENGTH

This ranges from -100dBm (minimum) to -10dBm (maximum), and decreases the further away you are from your router.

2 NETWORK INFO

Get detailed information about your network here — much of it is cryptic for less experienced users, but helps with troubleshooting.

3 LINK-SPEED

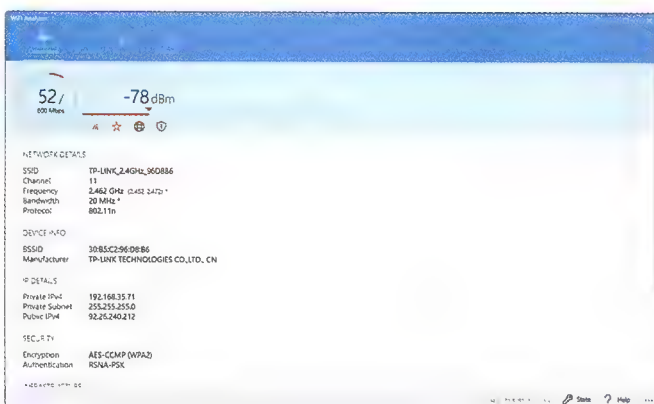
Gives you an estimate of your current network speed, as well as listing the maximum theoretical speed for your connection.

4 SWITCH ADAPTER

If you have multiple Wi-Fi adapters installed, click the '...' button and choose 'Settings' to access this screen and switch between them.

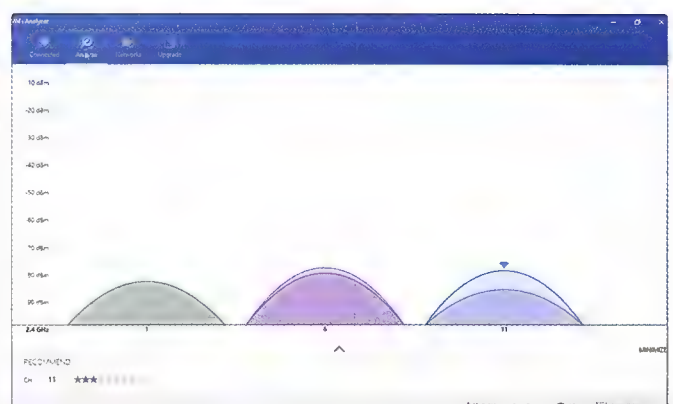
5 ALERT SYMBOLS

These symbols turn orange if there's an issue with the connection, channel (interference) internet access or security.



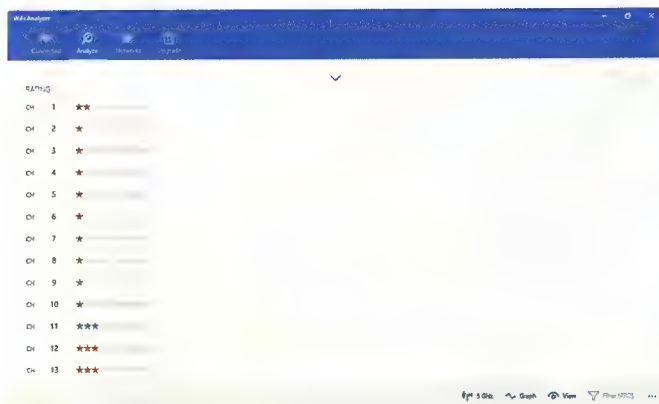
3 ANALYSE NETWORK INTERFERENCE

Where multiple network signals overlap, interference can occur if they're using the same channel to broadcast on. In areas where the signal is weak, look to see if the star symbol beneath the dBm line turns orange (it may flicker as the signal fluctuates, or be a permanent fixture if it's particularly weak). If it does, you may be able to improve performance by switching channel.

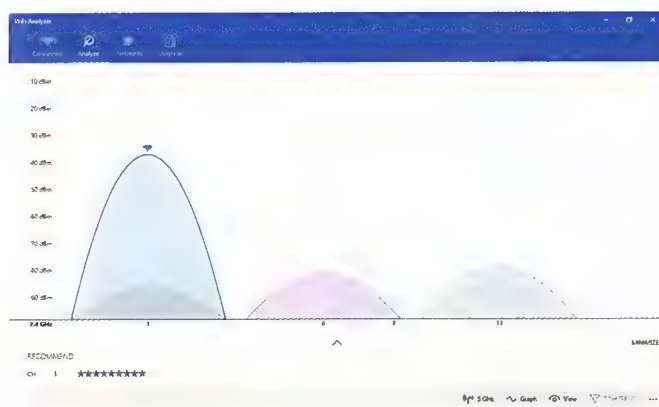


4 REVIEW OVERLAPPING SIGNALS

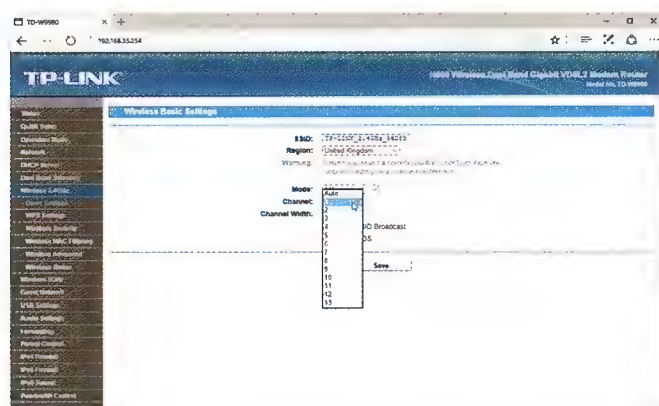
Switch to the 'Analyze' tab to view a graph depicting all detected networks, complete with their signal strength and what channel they reside on. Most networks broadcast on channels 1, 6 or 11, so you'll probably see a number of overlapping signals, with your own network identified by the Wi-Fi symbol above it. Tap the 'View' button to show extra detail, such as each network's SSID.



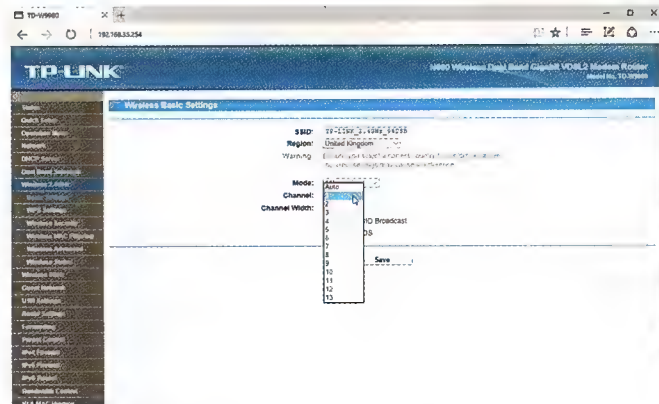
5 SHOW MORE INFO Beneath this main view is the currently recommended channel, complete with a star rating based on the signal strength. This may indicate the channel you're currently on is the best one, but tap it and you'll get a list of ratings for all available channels. Look for the channels with the highest ratings, then make a note of them should you wish to try a different one.



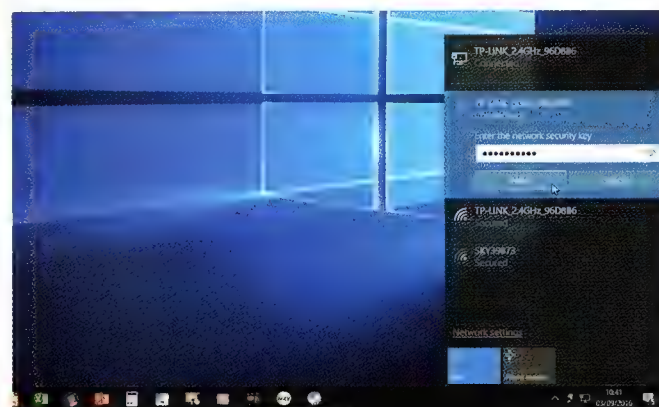
7 TEST CHANGE You can then return to WiFi Analyzer and see if your changes have helped improve the signal strength and quality of the connection. If it makes things worse, switch back or try a different channel. To avoid overlapping interference from other channels, switch between channels 1, 6 or 11 on a traditional 2.4GHz network (depending on which has the least congestion).



9 SWITCH CHANNEL Unlike 2.4GHz networks, channels don't overlap on 5GHz networks, so if you're sharing a channel with another network, you can switch to any different channel. Use the graph in WiFi Analyzer to identify the least congested channel available, then use your router's own configuration utility to manually switch channel. Once done, check the results in WiFi Analyzer.



6 SWITCH CHANNEL If you want to experiment with a different channel to see if it improves performance, you'll need to consult your router's documentation to find out how to change the channel. In most cases, this involves logging into its web-based interface and locating the appropriate section. Select your channel, click 'Save' and wait while your network adjusts to the change.



8 SWITCH TO 5GHz If you have a dual-band router, switch on the 5GHz network and move compatible devices over to it. Not only does this ease congestion on your own network, the 5GHz network is less commonly used, so there's less competition from other networks. If your PC has a 5GHz-compatible adapter, check for interference from WiFi Analyzer via the Analyze section — click '5GHz'.



10 YOUR NETWORK, DECONGESTED It's worth testing your signal in different areas of your home — you may find that what works in one area won't work in another due to the presence (and strength) of different networks. For extra tools, such as a handy beeper for indicating your network's signal strength, try the Pro version: tap '...' and choose 'Upgrade to PRO > Try for 12h'. The full version costs \$2.39.

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Build an affordable but powerful Linux box

Zak Storey demonstrates how to construct a punchy Linux PC!

THE CONCEPT

'Linux' is a fairly taboo word for most here at APC, yet we write about it a lot — and with good reason. It's a free, diverse, open-source operating system, with a huge breadth of potential. It rattles the cages of the likes of Microsoft and Apple, and constantly helps to improve the technological ecosystem we all call home.

However, due to the very nature of the beast, the fact that it's easy to

get hold of a free copy of the rebel OS, and most of its users are more inclined to run older hardware, the vast majority of Linux-powered systems tend to err on the side of caution when it comes to purchasing newer hardware. So for many people, the concept of a super-fast Linux system, powered by the latest Intel Z170 chipset and M.2 PCIe SSDs, is something of an oxymoron.

The plan with this project, then, was to satisfy two separate criteria.

Firstly, to build a super-fast Linux system, powered by a quad-core Intel processor in conjunction with the latest Samsung M.2 PCIe SSDs, and secondly, to keep the budget as low as humanly possible at the same time, to stick to the Linux ethos. Did we achieve it? Almost.

THE LINUX DREAM!

To start with, we knew we wanted to use a quad-core processor, preferably of Skylake origin. The newer chipsets would support M.2 drives over the PCIe bus, and the four cores of Skylake's mighty Core i5-6500 would be plenty for any demanding Linux task.

For a base hard drive, we opted for a Samsung PM961 256GB M.2 PCIe SSD. Coming in at a relatively cheap \$239, this OEM drive boasts a whopping 3,000MB/s sequential reads, and 1,100MB/s sequential writes, proving to be one of the best deals around when it comes to current NVMe drives. However, as it's an OEM drive, it's worth bearing in mind that you'll receive no support from Samsung with regard to drivers, troubleshooting or software issues. It's also hard to find at retailers, but at the time of print you could readily find them on eBay.

Our motherboard was a cheap and cheerful ASUS B150 A/M.2. At the low end of the pricing spectrum, it's a fairly well-equipped mobo capable of housing 8GB of DDR4, in conjunction with an M.2 drive, and a plethora of SATA drives. And our last worthy mention is the 550W Kolink budget power supply, which we scavenged from our storage containers. It's not available to buy right now, but swapping it over to an EVGA 500B would be more than enough to satisfy all your power needs – even with an additional GPU – without breaking the bank.

PARTS LIST

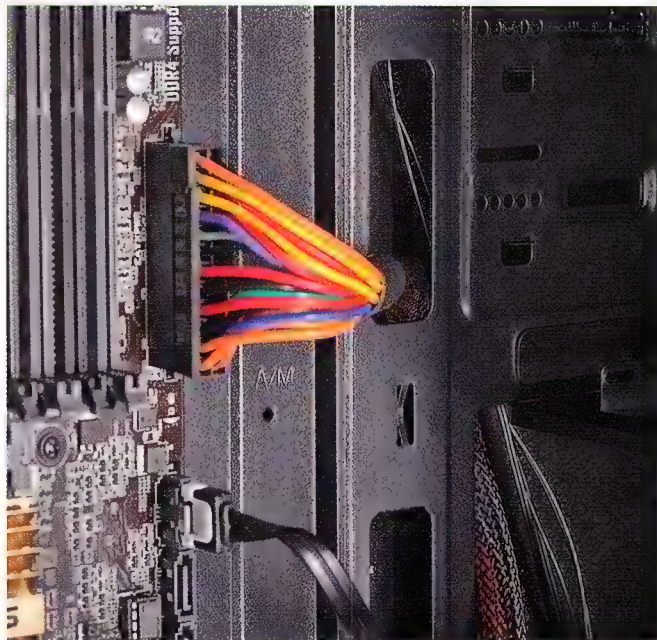
PART		STREET PRICE
CASE	BITFENIX NOVA ATX MID-TOWER CASE	\$59
MOTHERBOARD	ASUS B150M-A/M.2 MICRO ATX	\$119
CPU	INTEL CORE I5-6500 @ 3.2GHZ	\$299
MEMORY	TEAM ELITE+ 8GB (2 X 4GB) @ 2,400MT/S	\$64
GPU	INTEGRATED GRAPHICS	\$0
PSU	EVGA 500B	\$89
STORAGE 1	SAMSUNG PM961 256GB M.2 PCIE SSD OEM	\$239
STORAGE 2	WESTERN DIGITAL BLUE 2TB 5,400RPM HDD	\$99
TOTAL		\$968

"Coming in at a relatively cheap \$239, this OEM drive boasts a whopping 3,000MB/s sequential reads, and 1,100MB/s sequential writes, proving to be one of the best deals around when it comes to current NVMe drives."



1 REAR I/O PLATES

Whenever you start building any system, the first thing you should do (after stripping out everything you don't need from the case, of course) is install the rear I/O plate. On the more expensive boards out there, these are nicely designed, clean plates, with protective EMI-shielded padding. However, on the more budget-focused boards, you may find they are simply a thin sheet of tin, with a variety of pins sticking in place. Our best piece of advice is to try to bend these out of the way so you can install your motherboard securely afterward, and if that fails to work, snap the extra metal pins off entirely to make sure you keep everything installed in place. Rear I/O plates keep the vast majority of dust out of your system.



2 CABLE MANAGEMENT

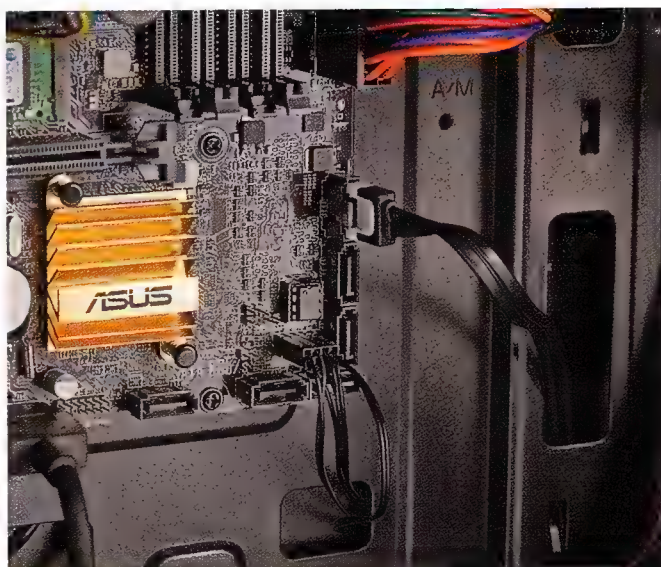
For this build, we opted to use one of BitFenix's Nova cases. Generally speaking, BitFenix makes some fantastic budget-oriented chassis, which beside looking good, generally make our lives a little easier when it comes to constructing a system. You can find these for about \$50 here and there, but we opted for the slightly pricier \$59 windowed variant. Cable management is slightly limited in these budget-friendly models, but we still managed to route the PSU cable up and through the rear of the chassis. Although this doesn't do much to make things look any tidier, it does help keep the cable out of the way of any graphics cards you may wish to fit in the future. We just wish we could say the same for the 8-pin CPU power.



3 CPU & M.2 INSTALLATION

Installing a CPU in the Skylake era is exceedingly easy. Simply lift up the metal retention lever located to the right of the socket, leaving the plastic protector in place. Place the CPU gently into the socket, with the golden triangle on the processor pointing in the same direction as the triangle mark on the retention bracket, slide the bracket back under the screw, and relock the retention arm. The protective cap should pop off, and you're all set. Word of warning for the less experienced: do this on a flat surface, with the motherboard lying flat. You can do it inside a chassis, but just don't do it vertically.

For M.2 SSDs, simply undo the screw located near the end of the M.2 slot, put the drive in the correct way (matching the slot up with the drive), press the drive down, and rescrew in place.



5 FRONT I/O CONNECTORS

There's nothing more frustrating to deal with than front I/O connectors. These fiddly cables ensure that all your power buttons, reset switches and LEDs work effectively, but attaching them to the motherboard can be a pain in the proverbial. If your motherboard doesn't have directions printed on it for what goes where, you'll have to dive into the user manual. Fortunately for the ASUS B150 A/M.2, the instructions are printed on the PCB around the front panel connectors. Our advice? Try to route the connectors through a rear panel to manage the mess, and ensure that the positive and negative sides of your LEDs are attached to the correct points, otherwise they won't operate.



4 FAN ORIENTATION

When it comes to budget cases, included fans tend to be pretty sparse. With the Nova coming with just a single 120mm airflow fan, we opted to reverse it and use it as an intake for the whole system, as opposed to an exhaust. Although this won't necessarily help a huge deal with dust control, drawing cool air in directly over the reference cooler, and down on to the motherboard, should help to alleviate any potential thermal throttling issues. That said, with the clock speed on the Intel Core i5-6500 only registering at 3.2GHz, and thanks to Skylake's exceptionally power-efficient architecture, it's highly unlikely we'd ever reach a point of thermal throttling, even with a stock cooler running at full load.



6 CPU POWER

In cases like the Nova, cable management space behind the rear panel is often an afterthought. This can make installation of the CPU 8-pin power particularly troublesome. Fortunately, in this build, thanks to the lack of add-in cards, we could run the CPU power straight up and across the board, taking care not to hit the stock cooler. If you were running a graphics card as well, however, a neat way of getting around this problem would be to install the PSU first, then route the CPU cable under the motherboard itself, taking care not to get in the way of any stand-offs. It can be a bit fiddly, but it's a neat way to keep a cable tidy, while simultaneously allowing GPUs to be installed.



1 The 8GB of DDR4 here is rated to operate at 2,400MT/s — it's worth noting that the B150 chipset can only support 2,133MT/s max.

2 Although a 2TB drive does bump up our overall spend, we wanted to create a versatile Linux box, regardless of whether you want to game, work or stream media from it.

3 There's actually a chunk of cable management just to the left of the hard drive cages, facing forward — we wedged a swathe of excess cables there to keep things looking a little tidier.

4 BitFenix even manages to include a toolless 5.25-inch drive bay for those still clinging on to their old Linux discs.

"This is the absolute basics of PC building: take a case, grab a processor, a standard PSU, two sticks of RAM and a few hard drives, and just slap it all together."

A lovely Linux experience...

For this reviewer, it's safe to say that Linux is a completely alien experience. Getting to grips with it certainly made for an interesting struggle. As a hardcore Windows fan, the concept of running the entire OS off a single bootable USB stick was mind-blowing. The versatility achieved by having the OS on a single drive to diagnose potential future hardware problems is high-on incredible, especially compared to an OS like Windows, where everything is tied down into authentication, personal accounts and Windows Updates.

That wasn't the only thing that impressed, however. The level of customisation available upon installation was equally mesmerising. Did you want to use a virtual partition system ahead of time? Fine. Encrypt the drive's OS and drive entirely? Okay. There are many other options equally possible on the portable desktop. Couple that with the ridiculously small install size, and it really is something worth trying, at least once, even by Linux's harshest critics.

The thing is, Linux users are to operating systems what we enthusiasts are to hardware. They're the tinkerers, the command-line delvers, those looking to tailor their desktops to exactly what they want to do. Whether that's an office PC, a gaming rig, a NAS,

a Plex Media Server, hell, even a mobile drone — all of it can be done through a variety of different distros ready to serve the user, most of which are free, and all of which are open-source.

And it's that open-source heritage that makes the OS so much more in tune with the market than even Windows can manage. 4K scaling by default is a given, the user interface is intuitive and easy to use, and the best features from both Windows and MacOS are seamlessly integrated by default. That's not to say it's not without its problems, of course. Driver support is unbelievably patchy, and even running an AMD processor provides its own set of challenges. AMD GPU drivers are included in most distros by default, but Nvidia generally performs better once the driver is installed. Having to perform tweaks for any serious problem via the command line can become tiresome, and even having to learn how a new operating system works can be frustrating at times.

Naturally, as far as performance goes, with the Samsung PM961 operating alongside the Intel Core i5-6500, it was certainly quick to boot. Lightning-fast, in fact. File transfer speeds were well into the 3GB/s range on the primary drive, with Cinebench R15 providing an impressive score just

shy of 620 points — what we'd expect from a core like this. Alas, that's where our performance charts end. Benchmarking games in Linux is challenging, if not impossible. Games such as *Middle-earth: Shadow of Mordor*, do boast an integrated benchmark, but showed a 50% decrease in overall average frames per second compared to the same hardware running Windows. For the most part, what we can say is that Linux does support Steam, and more games are slowly threading their way into the OS. But gaming isn't really what Linux is about.

Experience and performance aside, the build process itself was incredibly painless. This is the absolute basics of PC building: take a case, grab a processor, a standard PSU, two sticks of RAM and a few hard drives, and just slap it all together. There are no back plates to attach, no internal cooling to worry about, and no particular need for aggressive cable management. What you're left with is an astonishingly quick build with relatively little fuss, that performs exceptionally well, regardless of what platform you happen to be on. ■

Control your Raspberry Pi with your voice

Nate Drake **warms up his vocal cords.**

WHAT YOU NEED

If you only have a microphone with an audio jack, try searching Amazon or eBay for an inexpensive USB soundcard [Image B], which plugs into the USB port at one end, and has an output for earphones and a microphone at the other.

- There's a number of speech recognition programs available for the Raspberry Pi. For this project, we're using Steven Hickson's Pi AUI Suite, because it's powerful, as well as extremely easy to set up and configure.

GETTING STARTED

Once you follow the steps in the walkthrough (see page 99), you'll be able to start the installer. The Pi AUI Suite gives you a choice of a number of programs to install. The first question you are asked is whether it should install the dependencies. These, quite simply, are the files the Raspberry Pi needs to download for voice commands to work, so select 'Y' and press Return to agree to this.

- Next, you are asked if you want to install the PlayVideo program, which enables you to use voice commands to launch and play video files. If you choose 'Y', you're asked to specify the path to your media files – for example, /home/pi/Videos. Note that upper-case letters are important here. If the path is invalid, the program warns you.
- You're then asked if you want to install the Downloader program, which searches for and automatically downloads files from the Internet for you. If you choose 'Y' here, you're asked to provide settings for host, port, username and password. If you aren't sure of these, press Return for now to choose the default options in each case. The following program is Google Text to Speech Service, which you may wish to install if you want the Pi to read out the content of text files. In order to use this service, the Raspberry Pi needs to be connected to the Internet, because it connects to Google's servers to 'translate' the text into speech, and then plays an audio file with the Pi's media player.
- If you decide to install this, you need



a Google account. The installer asks you to enter your username. Do so, then press Return. You're then prompted for your Google password. Enter this, and press Return again.

MORE SOFTWARE OPTIONS

The installer also offers you the chance to install Google Voice Commands. This uses Google's own speech recognition service. Again, you're asked to provide your Google username and password to continue. Whether or not you choose the Google-specific software, the program also asks whether you want to install the YouTube scripts. These tools enable you to speak a phrase such as "YouTube fluffy kittens", which then causes a relevant video clip to be played.

- Finally, the program gives you the option to install Voicecommand, which contains some of the more useful scripts, such as being able to launch your web browser by saying the word "internet".
- The program asks you if you want Voicecommand to set itself up automatically. If you experience an error at this stage, follow Step 3 of the walkthrough on page 99.

TWEAK THE SETUP

Once the Voicecommand program is installed, you may wish to make a few basic changes to the setup before fine-tuning your configuration.

- Open Terminal on your Pi or connect via SSH and run the command `sudo voicecommand -s`.

- You are asked a series of yes/no questions next. The first question asks whether you want to permanently set the continuous flag. In plain English, the Voicecommand program is asking whether, each time you run it, you want it to continuously listen for your voice commands. Select 'Y' for now. Next, you are asked whether you want the Voicecommand program to permanently set the verify flag. Selecting 'Y' here means the program expects you to say your keyword (by default, the word 'Pi') before responding to your commands. This can be useful if you want to set the Raspberry Pi to listen continuously, and don't want it to act on everything you say out loud.
- The following prompt asks if you want to permanently set the ignore flag. This means that if Voicecommand hears a command that's not specifically listed in your configuration file, it tries to look for a program in your installed applications and run it. For instance, if you say the word "leafpad", which is a notepad application, Voicecommand searches for and runs this even if not specifically told to.
- We do not recommend you enable this feature. Because you're running Voicecommand as a SuperUser, there's too much risk that you could inadvertently tell the Pi a command that could harm your files. If you want to set up extra apps to work



```

pi@raspberrypi: ~/PIAUISuite/YouTube
C
File Edit View Search Terminal Help
outside the config file? (y/n)
n
Do you want to permanently set the quiet flag so that it never uses audio out to
speak? (y/n)
y
Do you want to permanently change the default duration of the speech recognition
(3 seconds)? (y/n)
y
Type the number of seconds you want it to run: ex: 3
3
Do you want to permanently change the default command duration of the speech reco
gnition (2 seconds)? (y/n)
n
Do you want to set up and check the text to speech options? (y/n)
y
First I'm going to say something and see if you hear it
Did you hear anything? (y/n)
y
If you heard the word FILL (or FILLER or FILLER-FILL) at the beginning of the sen
tence, the filler flag should be set to 0 or be blank
Do you want me to permanently set the filler flag to 0? (y/n)
y
The default response of the system after it finds the keyword is "Yes Sir?"
Do you want to change the response? (y/n)
y
Type the phrase you want as the response:

```

with Voicecommand, you can edit the configuration file in each specific case. (See 'Voice Command Tweaks', over the page, for more information.)

- Voicecommand then asks you whether you wish to permanently set the quiet flag, so it doesn't give a verbal response when you speak. Choose 'Y' or 'N' as you see fit.

MAKE YOUR PI TALK

Next, you're asked if you want to change the default duration for speech recognition. You should only change this if you're finding the Pi is having trouble hearing your commands. If you choose 'Y', you're asked to type in a number — this is the number of seconds that the Pi listens for a voice command, and the default is 3. The program then gives you a chance to set up the text-to-speech options. Turn up your volume before doing this. The program attempts to say something, and asks whether you have heard it.

- The default response of the system when responding to your keyword is "Yes, sir?" Choose 'Y' on the next prompt to change this, then type in your desired response, such as "Yes,

ma'am?" [Image C]. Press Return when you're done. The system plays back the response for you to confirm whether you're happy with the result.

- The procedure is the same for the default message for when the system receives an unknown command. The default response is "Received improper command", but you can change this to something less robotic if you prefer, by typing 'Y', then your chosen response — for example, "Unknown command".

TALK AWAY!

You are now offered the chance to set up the speech recognition options. This automatically checks whether you have a compatible microphone installed in your Raspberry Pi. Voicecommand next asks you whether you want the Pi to check your audio threshold for you. Make sure there is no background noise, press 'Y', then hit Return.

- It then asks you to speak a command to check that it has the correct audio device selected. The program automatically determines the right

audio threshold for you, so type 'Y' to choose this.

- Finally, the Pi asks you if you want to change the default keyword (Pi) to activate voice commands. Type 'Y', then enter your new keyword. Press Return when done. You are then asked to speak your keyword to acclimatise the Pi to your speaking voice. If this seems correct, type 'Y' to complete the setup. Follow Step 6 of the tutorial over the page to run the Voicecommand software. Try to start out with a few simple commands. (See Basic Voice Commands below, for more information.) Once you're comfortable with these, run the command `sudo killall voicecommand` to shut down the program, and edit your configuration file if you wish.

HEXING VOICES

Voice recognition software is a work in progress, and the Pi may not recognise everything you say. To improve your chances, be sure to stay near the USB microphone, and speak slowly and clearly.

Basic voice commands

Once installation of the Raspberry Pi AU-Headset is complete and you have run `sudo voicecommand -c` to set it to listen, you need to prime it with a keyword. By default, the keyword is 'Pi', but feel free to alter this to something easier, such as the word 'Jessie'.

Next, you should try out a few of the built-in voice commands.

YouTube: Saying "YouTube" and a video title automatically loads a full-screen video of the first relevant YouTube clip. This is similar to Google's 'I'm feeling lucky'. Say "YouTube" and the name of the video in which you're interested — for example, "YouTube fluffy kittens".

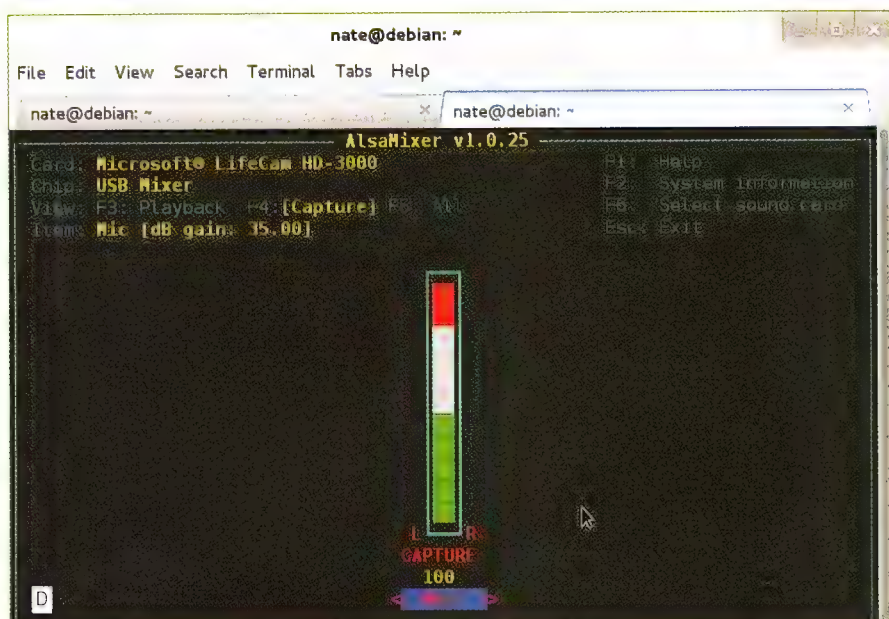
Internet: Saying the word "internet" launches your web browser. By default, this is the Pi's built-in browser Midori,

although you can change this.

Download: Saying the word "download" plus a search term automatically searches the Pirate Bay website for the file in question — for example, you could say "Download Ubuntu Yakkety Yak" to get the latest version of the Ubuntu Linux operating system.

Play: This command uses the built-in media player to play a music or video file — for example, "Play mozartconcert.mp4" would play that particular file located in the media folder you specified in setup, such as `/home/pi/Videos`.

Show me: Saying "show me" opens up a folder of your choice. By default, the command doesn't go to a valid folder, so you need to edit your configuration file to a valid location — for example, `show me=/home/pi/Documents`.



- If you're still having trouble being understood, open Terminal on your Pi or connect via SSH and run the command `alsamixer` to open your sound settings. Press F4 to choose audio input, then press F6. Use the arrow keys to select your USB device, then press Return. This controls the volume of your USB microphone. Use the up arrow to push it to max (100) [Image D].
- If your USB microphone isn't being detected, it might need more power than the Raspberry Pi's USB ports can provide on their own. The best solution to get round this is to use a powered USB hub. The Pi Supply website sells a seven-port powered

hub for just US\$13 (bit.ly/2c8H10y). A powered USB hub can also be useful if you want to use an external hard drive with your Raspberry Pi.

TROUBLESHOOTING TIPS

Once the Download program is installed, if you experience an error connecting, bear in mind that access to the PirateBay website may be restricted where you are. In order to download files, you also need a BitTorrent client for the Pi, such as the program Transmission. You can install this by opening Terminal or connecting to your Pi over SSH and running the command `sudo apt-get install transmission`. Help with getting

started and how to use the client is available from the Transmission website at forum.transmissionbt.com. Needless to say, you should only download files with the permission of the copyright holder.

- If you choose to use Google Voice Commands or Google TTS (Text to Speech), bear in mind that anything you say and any text files you submit are sent to Google's servers for translation. Google claims not to retain any of this data, but even if it is to be believed, any data transmitted over the internet can potentially be intercepted by a third party. Google does encrypt your connection to reduce the chance of this happening, however.
- If you find you're happy with the voice command feature, you might prefer the software to start automatically each time you boot the Pi. If so, open Terminal on your Pi or connect via SSH and run the following command: `nsudo nano /etc/rc.local`
- This opens the file that determines which processes start up when your Raspberry Pi boots. By default, this script does nothing. Use your arrow keys to scroll to the bottom of the file and, just above the line reading `exit 0`, type the following: `sudo voicecommand -c`
- Press Ctrl-X, then Y, then Return to save your changes. Feel free to reboot the Pi at this stage to make sure it works. If you're unsure whether Voicecommand is running, open Terminal and run the command `ps -a` to show a list of running processes.

Voice command tweaks

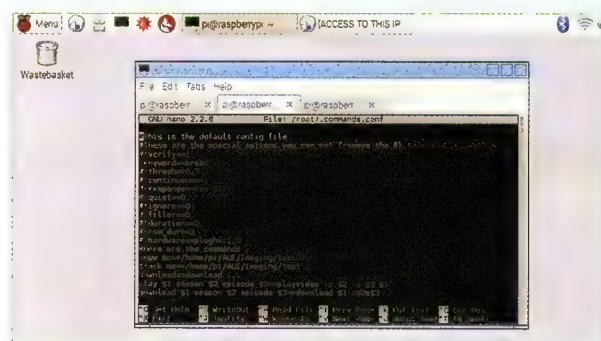
Once your Voicecommand software is up and running, you can edit the configuration file to add new commands or modify existing ones.

Run the command `sudo nano /root/.commands.conf` to view the configuration file. As you'll see, most of the lines begin with a `#` symbol, which means the Pi ignores them. Delete the symbol to activate the line. If, for instance, you want to change the keyword that activates the voice recognition software from "Pi" to "Jessie", you would change the line from `#!keyword==pi` to `!keyword=jessie`.

If you use the Firefox web browser instead of Midori on your Raspberry Pi, you may also want to change `~Internet==midori &` to `~Internet==firefox-esr &`.

The software can run any command. For instance, to open the desktop by saying the word "desktop", add the following line to the end of the file: `desktop==home/pi/Desktop`. You can also launch programs as you would from the terminal — for example, `notepad==leafpad`.

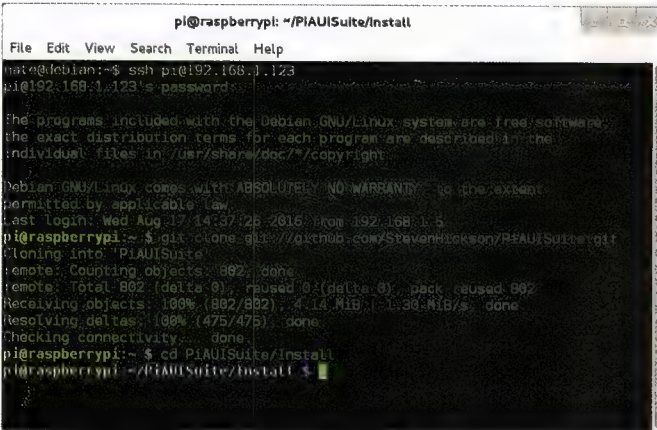
As you're talking to your Raspberry Pi, you may want it to respond to you with speech. Do this first by opening Terminal and installing the speech synthesis software Festival with the



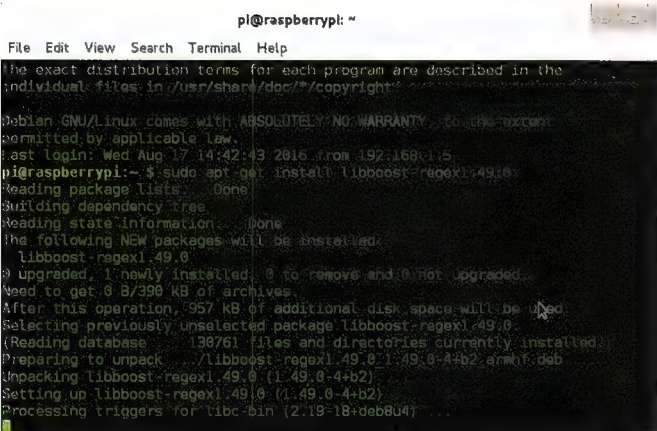
following command: `sudo apt-get install festival`. The basic format to get the Raspberry Pi to talk is `echo "Your message here" | festival -tts`. You can also have the Pi read out system information. For example, if you wanted the Pi to tell you the date and time, you would need to add the following line to the config file:

`time==echo "The time is" | festival --tts && date | festival -tts`

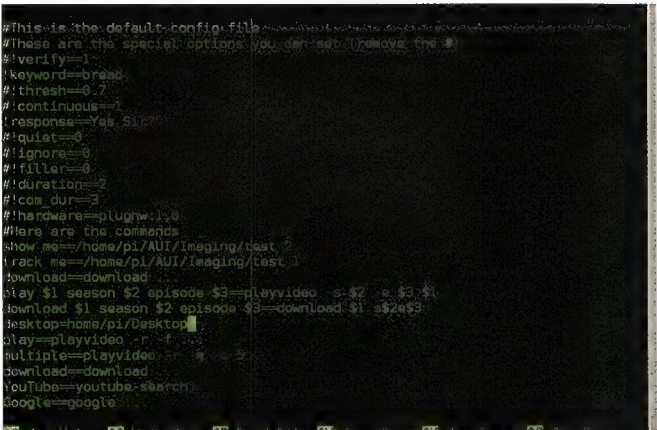
Set up voice commands on your Pi



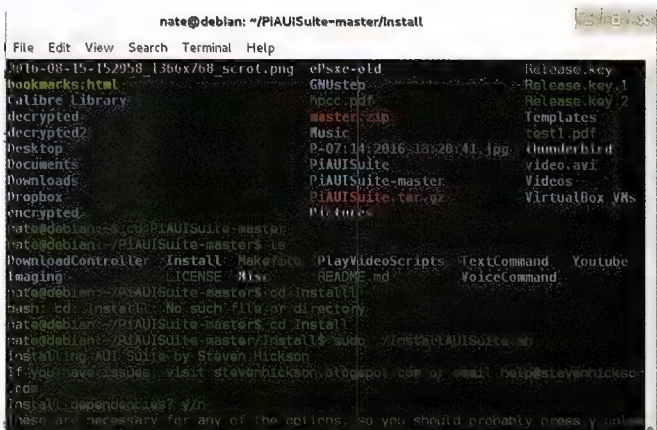
1 DOWNLOAD INSTALLATION FILES
Open Terminal on your Raspberry Pi or connect via SSH and download the installation files by running the command `git clone git://github.com/StevenHickson/PiAUISuite.git`. When the download is complete run `cd PiAUISuite/Install` to open the installation directory.



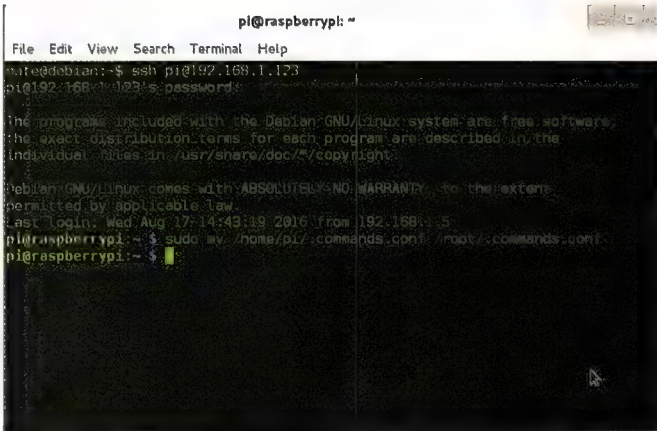
3 INSTALL BOOST C++ LIBRARY
If you encounter an error when trying to set up the Voicecommand program, run `sudo apt-get install libboost-regex1.49.0` to install the necessary software. Next, run `sudo ./InstallAUISuite.sh` to run the installer, again.



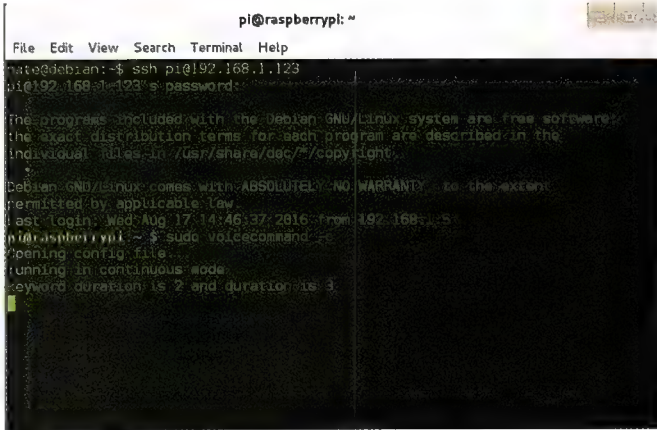
5 EDIT CONFIG FILE
Use the command `sudo nano /root/.commands.conf` to inspect your configuration file. You can now change your keyword or add extra commands. (See Voice Command Tweaks opposite for more information.)



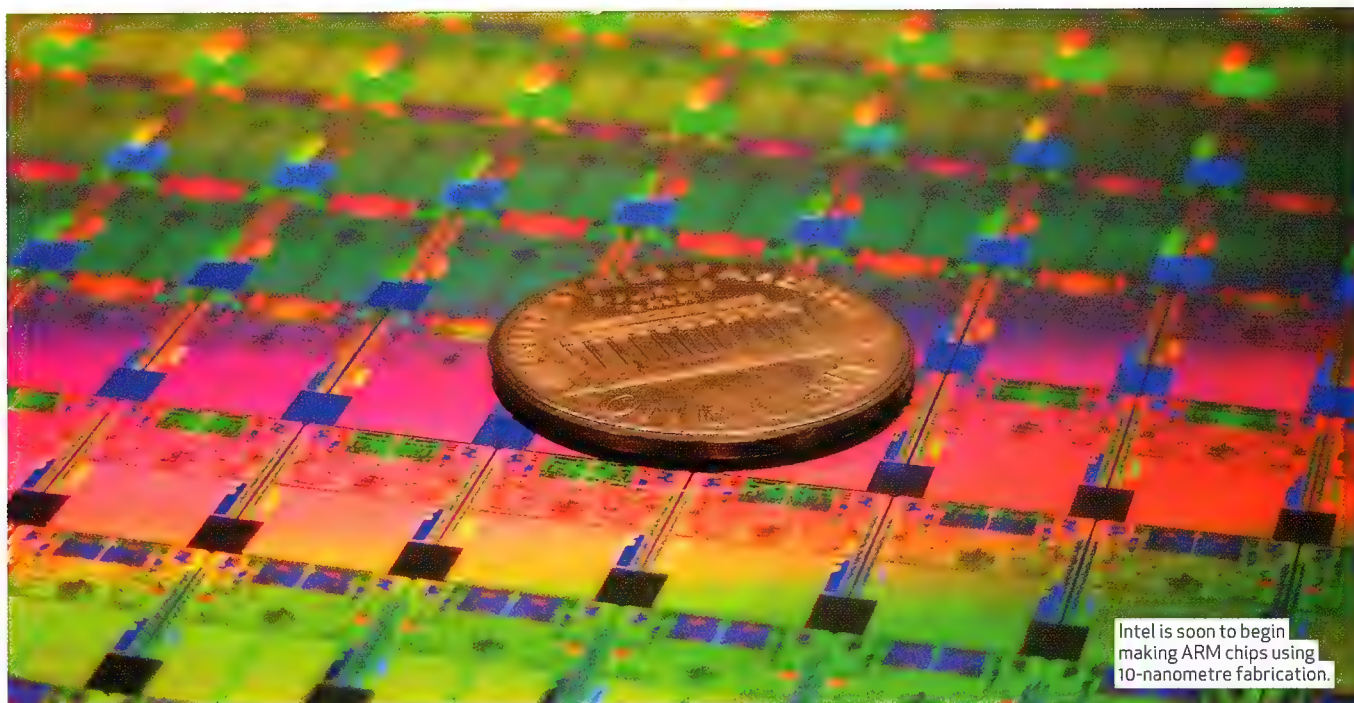
2 RUN THE INSTALLER
Use the command `sudo ./InstallAUISuite.sh` to run the text installer. Choose `y` to install any dependencies, and then work your way through the installation wizard. See the main article for more details about how to do this.



4 COPY CONFIGURATION FILES
Because you're going to be running the Voicecommand program as the root user, you need to use the command `sudo mv /home/pi/.commands.conf /root/.commands.conf` to copy across the necessary configuration files.



6 RUN VOICECOMMAND
Use the command `sudo voicecommand -c` to start the software. It automatically listens out for your keyword. You can then give it further commands, such as "YouTube fluffy kittens".



2020 vision — Android tech on the way

New chips, hardware encryption, dual-lens phones, 5G modems and 7-nanometre transistors... Darren Yates reports on the technology coming to Android through to 2020.

Everyone clamours for the latest news on new smartphones these days, but if you really want to know what's coming up, look for news on the upcoming and recently introduced tech that goes inside these devices. News of new chip developments today, even down to transistor-level, will give you a pretty fair idea of what you'll see tomorrow and over the next few years. And there's been plenty going on of late, with news from major players Samsung, Qualcomm, TSMC and Intel that will affect what you buy through to 2020 — and beyond.

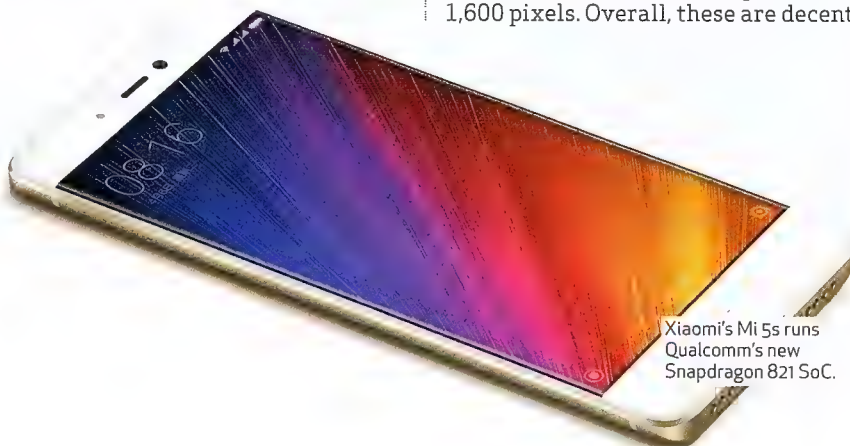
QUALCOMM'S NEW SOCS

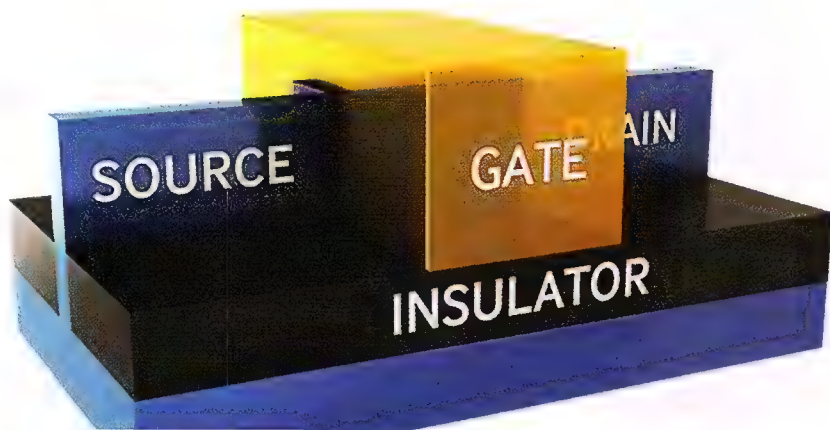
Nearly every smartphone has a CPU or System on a Chip (SoC) conceived by chip designer ARM. But ARM doesn't make its chips; it licenses its tech to others to make. Qualcomm is one of the flagship ARM chipmakers and one of a select group with a licence to not only build standard ARM Cortex chips designs, but the go-ahead to create its

own ARM-based silicon. In the last few weeks, it's been busy rolling out the welcome mat to a range of new SoCs likely to launch a raft of new mid-level mobile devices in 2017. All released under the Snapdragon family business, these new chips are the Snapdragon 653, 626 and 427.

According to Qualcomm specs, the Snapdragon 653 packs in eight cores — four Cortex A72s for the performance stuff and four Cortex A53s for lower

power/lighter duty work in ARM's 'big.LITTLE' configuration. It'll top 1.95GHz in clock speed and features a Qualcomm in-house Adreno 510 GPU. Interestingly, though, it's designed around 28-nanometre (28nm) scale production, which really makes it more 'tried and true' than 'latest and greatest'. Still, with that many cores, it'll be fast enough to handle 4K (3,840 x 2,160-pixel) video capture at 30fps. The 653's display driver will also handle screen resolutions up to 2,560 x 1,600 pixels. Overall, these are decent





Fin Field Effect Transistors (FinFETs) use a 3D structure to run at low-scale.

specs, even for flagship phones, but as we'll see, the 28nm production scale is well off the pace.

The Snapdragon 626 is also an eight-core SoC, but features all Cortex A53 cores. In contrast to the 653, the 626 will be stamped using a much smaller 14nm production scale, which should aid power efficiency. In line with the drop from the 653, the 626 will also use the slightly slower Adreno 506 GPU core. The SoC can only handle 1,920 x 1,200-pixel resolution displays, which becomes 1080p (1,920 x 1,080 pixels) by the time you reach actual mobile device panels.

Meanwhile, the Snapdragon 427 is a straight quad-core Cortex A53 design built for 28nm production with an entry-level Adreno 308 GPU core. It's good for 1080p video capture and playback; however, its on-board display support only goes as far as 720p (1,280 x 720/800-pixel) resolution, so we'd suggest not to expect seeing this one get beyond budget phones around the \$200 mark.

MORE DUAL-LENS PHONES

Apple made a bit of a splash with the iPhone 7 sporting dual lenses, but dual-lens phones have been floating around this last year or so, thanks to the HTC One M8, LG's G5 and Huawei's Leica-powered P9. But while these have been limited to flagship devices, that shouldn't be the case in 2017. All three of Qualcomm's new Snapdragon SoCs

feature dual image signal processors (ISPs), the core technology needed behind dual lenses. What's more, even the entry-level Snapdragon 427 can support up to 16-megapixel (MP) image sensors, so there's considerable potential for dual-lens cameras filtering down into the mid-range market sometime during the year. Still, while the necessary functionality will exist in these chips, it'll be up to phone vendors to implement the second image sensor and lens for it to actually happen.

HARDWIRED ENCRYPTION

The fastest-growing area of mobile tech right now — probably the fastest-growing area in tech full-stop — is security. Google announced Nougat/Android 7.0 would support a new file-based encryption (FBE) to secure files, but the company states FBE requires devices to have encryption speed of at least 50MB/second to ensure "a good user experience" (tinyurl.com/znvwhvj) and probably with good reason. Android's previous software-based Full Disk Encryption



Huawei's P9 phone featured twin lens powered by camera maker Leica.

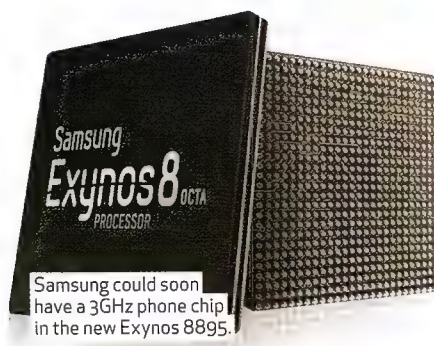
(FDE) was shown to take out a sizeable chunk of the Nexus 6's performance (tinyurl.com/lynhh92). Google then claimed to have largely sorted this out on its Android 6.0-powered Nexus 5X and 6P devices, thanks to new 64-bit ARM chips with their ARMv8 instruction sets. Despite still using software-based encryption, encryption performance was said to be faster than what was available in hardware at the time (tinyurl.com/p2cj7og).

But it appears now that Nougat's FBE can take advantage of the hardware encryption inside the Snapdragon 820 and 821 SoCs, with phones said to be able to offload encryption to the chip's hardware crypto engine, improving performance. The 820 also recently received hardware security certification to Federal Information Processing Standard (FIPS) 140-2 Level 2 from the U.S. National Institute of Standards and Technology (NIST).

As for differences between the Snapdragon 820 and 821, the answer



LG's G5 phone may soon get dual-lens competitors via new Qualcomm chips.



Samsung could soon have a 3GHz phone chip in the new Exynos 8895.

seems to be 'not that much'. According to XDA-Developers (tinyurl.com/zygojol), it turns out that the 821 is a mid-life revision of the 820 with some silicon tweaks, resulting in two versions of the 821 – the headline version, now clocking at up to 2.4GHz, plus a second, revving at the 820's original 2.15GHz. It's this second version that Google's new Pixel and Pixel XL phones are said to be using. A quick check of the Pixel/Pixel XL specs show the Snapdragon 821 SoC is indeed clocking in at 2.15GHz.

INTEL MAKING ARM CHIPS

Not long ago, you'd be forgiven for thinking hell would freeze before chip giant Intel would start making chips using technology from rival ARM. However, reality is often more pragmatic than dramatic, with Intel's Custom Foundry business and ARM recently announcing Intel will begin manufacturing chips with its upcoming 10nm fabrication process using ARM's Artisan Physical IP core technology. According to ARM's official blog, the deal includes intellectual property (IP) agreements for two future Cortex A-series processor core designs in either straight 'stand-alone' or big.LITTLE dual-family configurations (tinyurl.com/jar9tr3).

This will see Intel in direct competition with Samsung and Taiwanese leader TSMC – and word is Intel already has licensing deals in place with LG to start punching out ARM chips. The news comes on the back of Intel taking the axe to its own mobile-focussed Atom chip



family earlier in the year (tinyurl.com/j28m9yw).

It's also no secret the PC business is sagging for Intel as global PC sales continue to slide, coming off another 5.7% in the September quarter, compared with the same period in 2015 (tinyurl.com/gtdh4jp). In response to the flagging demand, the company announced in April plans to slash some 12,000 jobs worldwide (tinyurl.com/hfjp6x9). With mobile devices still showing growth, a deal with ARM would seem a pragmatic approach to keeping its fab labs busy.

One prize for Intel in the move would be a slice of the Apple A-series SoC market. Apple designs its own chips for iPhones and iPads, but relies on the likes of Samsung and TSMC to make them. Having Intel as another possible manufacturing partner, when it already supplies Apple with CPUs for its computers and laptops, could help Apple cut a better deal from its existing manufacturing partners to lower production costs.

SAMSUNG MAKES 10NM FINFETS

Meanwhile, the Galaxy Note 7 debacle has Samsung on the back foot, but still, the all-round Korean giant is pressing on with new technology. In the chip-production stakes, everyone is racing to produce transistors at a miniscule 10-nanometre scale and Samsung claims to have reached the 'mass production' finish line first, ahead of rivals Intel and TSMC (tinyurl.com/h7qdrp8). Despite its recent hiccups, the company announced that it is building new chips using 10nm FinFETs or 'fin field effect transistors'. To give you an idea of the long lead times technologies often go through, these 3D transistors were first hatched by researchers at the University of California in 1999 (tinyurl.com/hwm8zpy, PDF), but have only been in production, starting with Intel, since 2011.

Samsung stated recently the new production scale will give it a 27% performance increase and a 40% reduction in power consumption over

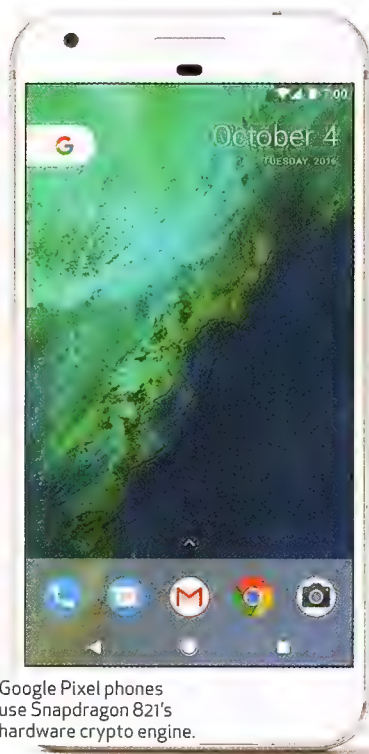
previous-generation 14nm tech (tinyurl.com/zhrwvwx). What does that mean for us? The same as every other new reduced-scale production process – faster devices with better battery life. Rumours are the first 10nm Samsung chip off the production blocks could be the 'Kanchen' – codenamed Exynos 8895. If the rumours are correct, the 10nm scale could allow clock speeds up to 3GHz, pushing well into desktop PC territory. The 8895 is expected to also feature the new ARM Mali-G71 graphics core, which could well be the fastest mobile GPU going around and claimed to be 1.8 times faster than the 12-core Mali-T880 powering current Galaxy S7 devices.

That's a good thing, because take the rumours further and the Exynos 8895 could well find a home in the 2017 Galaxy S8 smartphone, which itself is likely to feature a 4K-resolution AMOLED display panel in addition to a whopping 6GB of RAM.

However, 10nm is just one battle in an ongoing chip production war – TSMC has announced it'll begin manufacturing trials for an even smaller 7-nanometre scale during 2017 and Samsung, in conjunction with IBM and Globalfoundries, is expected to launch into 7nm production before the end of 2018 (tinyurl.com/jef8tdp).

5G HARDWARE

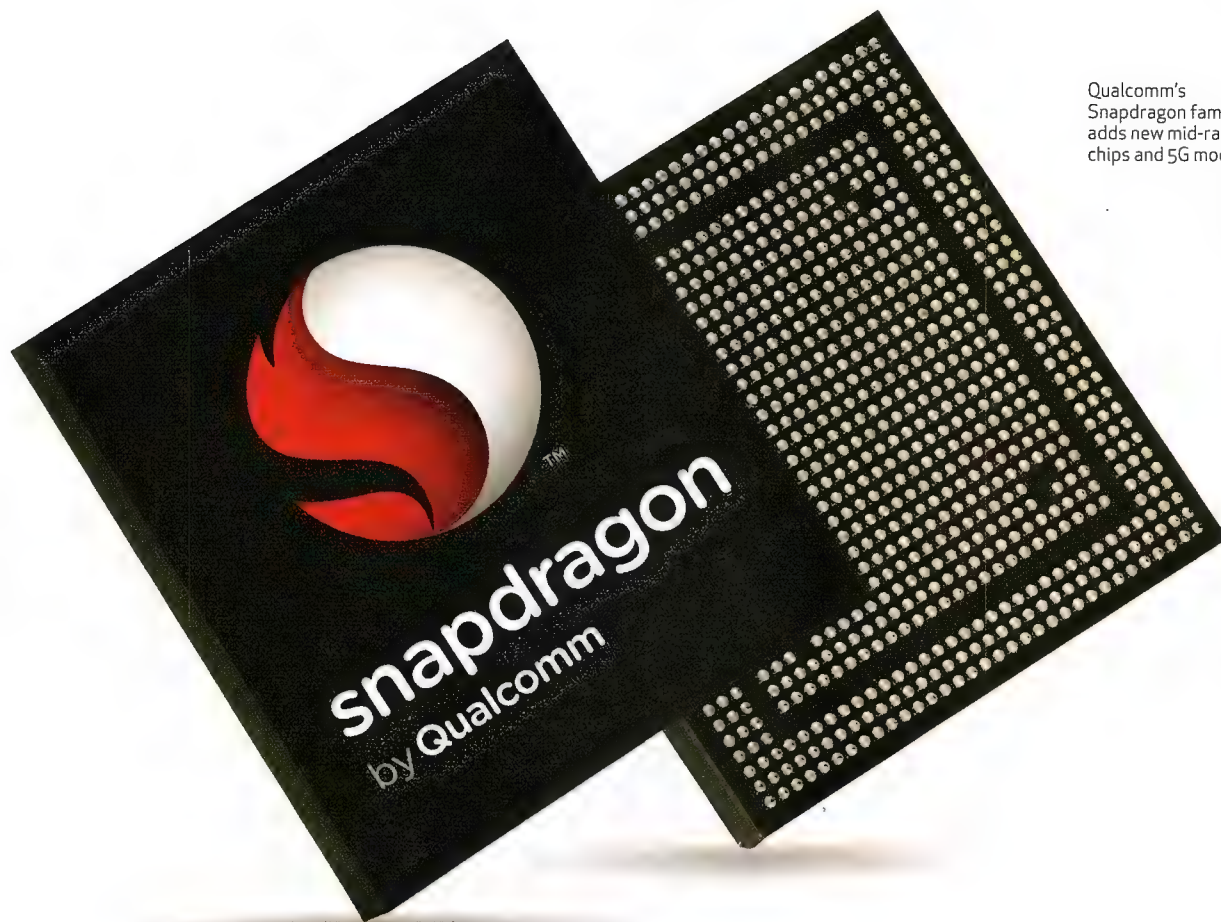
There's plenty of talk surrounding 5G networks and it's no secret Telstra has been trialling Ericsson-powered 5G mobile network technologies in a



Google Pixel phones use Snapdragon 821's hardware crypto engine.



The Galaxy S7's successor is likely to feature 10-nanometre transistors.



Qualcomm's Snapdragon family adds new mid-range chips and 5G modem.

Melbourne testbed, with the telco reporting in September download speeds in excess of 20Gbps.

However, my personal rule of thumb is to only get excited by a technology when it actually makes it to mass-production silicon. We recently moved a step closer to that milestone with Qualcomm announcing the world's first 5G-modem. The Snapdragon X50 is claiming to reach download speeds of up to 5Gbps – just not any time soon. In fact, OEMs won't see samples of the X50 until the second half of next year, which means we won't likely see it in phones until 2018.

For 5G to get off the ground, it needs phones and it needs a network, but network testing and chipset announcements at least get 5G off the drawing board, even if it's still a couple of years before we're downloading the latest Marvel movie in 4K resolution.

MMWAVE PHONES

But to get that speed, the X50 has to operate in the 28GHz part of the frequency spectrum, which makes the 5GHz slot used by 802.11n/ac Wi-Fi look like pudding around on the AM commercial-radio band. At 28GHz, wavelengths are measured in millimetres (hence the term 'mmWave' or 'millimetre-wave') and the problem with radiowave propagation as you go up in frequency is that those waves don't travel as well – to say they can

be spooked by their own shadow isn't far from the truth, given rain drops are known to cause signal loss at that frequency. In other words, unless you're in line of sight of the cell tower, getting 5Gbps is near-on impossible. As a result, everyone's working on 'non-line-of-sight' (NLOS) technologies to get around these inherent problems, including adaptive narrow beamforming and beam tracking through multi-element antennas (tinyurl.com/h4v9kqg).

However, what isn't strictly certain yet is where on the radio-frequency dial 5G will operate. The UK's OFCOM (Office of Communications) has reportedly suggested bands between 6GHz and 100GHz. A white paper from National Instruments quotes the International Telecommunications Union (ITU) proposing a range of six bands between 24GHz and 86GHz, while the Federal Communications Commission (FCC) in the US has plans for four bands operating on 28GHz, 37GHz, 39GHz and 64–71GHz (tinyurl.com/hxxx8x2). The paper further adds that 5G development will take place in two phases – the first will run up until September 2018 and research commercial needs in the spectrum below 40GHz. The second phase kicks off in 2018 until December 2019 and will look at frequencies up to 100GHz.

Right now, very little operates commercially in this region of the

spectrum and no doubt governments around the world will be lining up to auction it off to the highest bidders. (According to the Australian Communications and Media Authority, AAPT and NBNCo had 28/31GHz Australian spectrum licences that expired in early 2014, tinyurl.com/z32cnv2, PDF, 'Executive Summary'.)

In the meantime, Qualcomm's other modem release – the new X16 LTE modem – has been at work in Melbourne, giving Telstra a taste of 1Gbps download speeds on the current 4G LTE network. Telstra is expected to unleash the Gigabit 4GX network in Sydney, Melbourne and Brisbane CBD areas (tinyurl.com/hq86aae), with suggestions elsewhere that the X16 LTE modem could appear in Qualcomm's next flagship Snapdragon SoC (probably the 830) sometime in early 2017.

AUSTRALIA LEADS THE WAY

In a world where most of the tech news originates from Europe, Asia or the US, it's nice to see that Australia continues to punch well above its weight. Having the world's first Gigabit LTE network implementation bodes well for 5G and gives local engineers world-class experience. Hopefully, that goes a long way to keeping more tech jobs in Australia. Now that is something to get excited about! ■

Coding 32-bit STM32 chips with Arduino IDE

Coding low-cost 32-bit chips can be done using the Arduino software. Darren Yates reveals the tools and know-how you'll need.

Last month, we introduced the idea of making the jump from 8-bit Arduino boards to building your projects using more powerful 32-bit ARM Cortex M-series chips, similar to those powering wearable devices like Fitbit fitness bands. Now ideally, you'd use dedicated integrated development environment (IDE) tools such as System Workbench for STM32 (www.openstm32.org), but you can also code certain Cortex M-series chips using the standard free (and simpler) Arduino IDE. We recommend this only for those with reasonable Arduino experience.

ST-LINK V2 USB ADAPTER

Unlike the Arduino boards, most generic Cortex M-series boards don't have built-in USB bootloader software to allow the board to be recognised by your PC via its USB port. Sure, the port is there on the board, but without that bootloader code, Windows won't recognise it. What you need is a USB-to-serial adapter and given the majority of low-cost Cortex M-series boards on eBay and elsewhere use the popular STM32 series from chipmaker STMicroelectronics, we'll use its

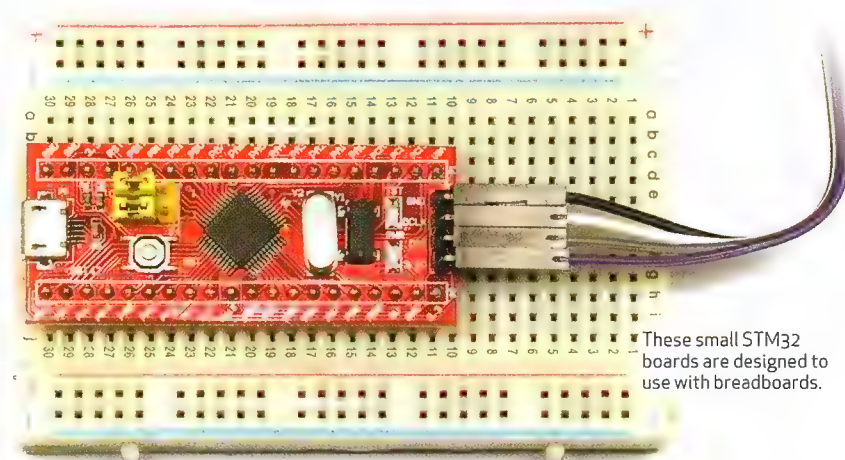
ST-LINK v2 USB-to-serial adapter. You can pick one up for around \$5 on eBay. It's essentially a USB Type-A plug on one end and a series of header pins on the other, providing the USB link between your PC and the STM32 chip to allow the Arduino IDE to code it. You don't need to worry about adapter device drivers – Windows will find the driver software online when you plug it in.

Now there are two STM32 chip families commonly found on most boards – the 72MHz STM32F103 series based on the ARM Cortex M3 or the

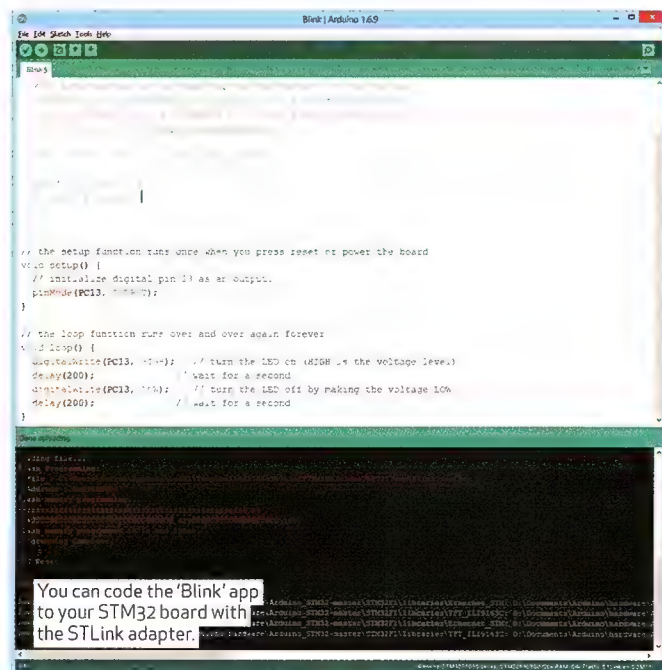
more recent 48MHz STM32F030 built on the ARM Cortex M0. Boards using either of these sell for under \$5 on eBay, but we recommend STM32F103-based boards.

ARDUINO 32-BIT LIBRARIES

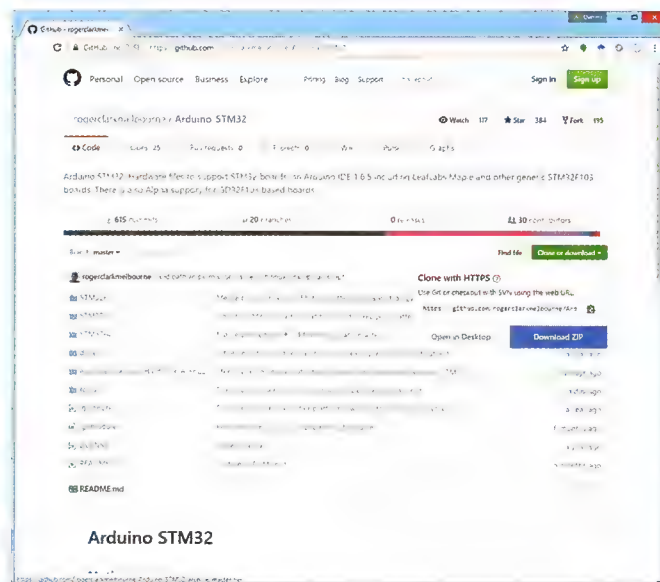
Before you go any further, you need to update your Arduino IDE with the 32-bit ARM core libraries (arduino.cc). You write your code in the relatively high-level language known as 'Wiring', which is a loose C++/Java translation. The Arduino IDE converts or 'compiles' this code into machine code the STM32 chips can



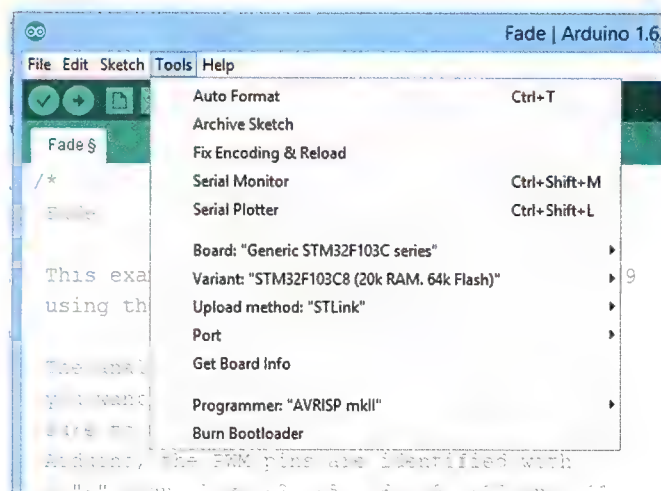
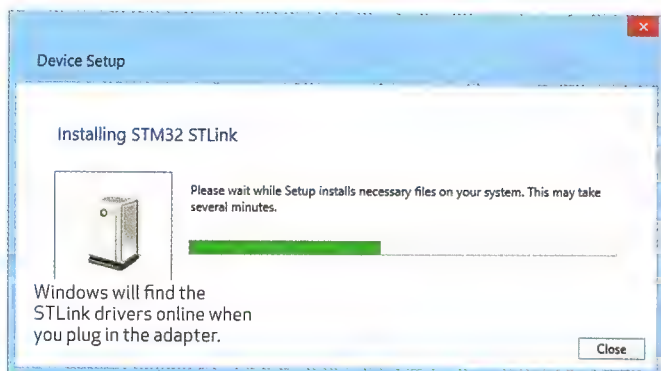
These small STM32 boards are designed to use with breadboards.



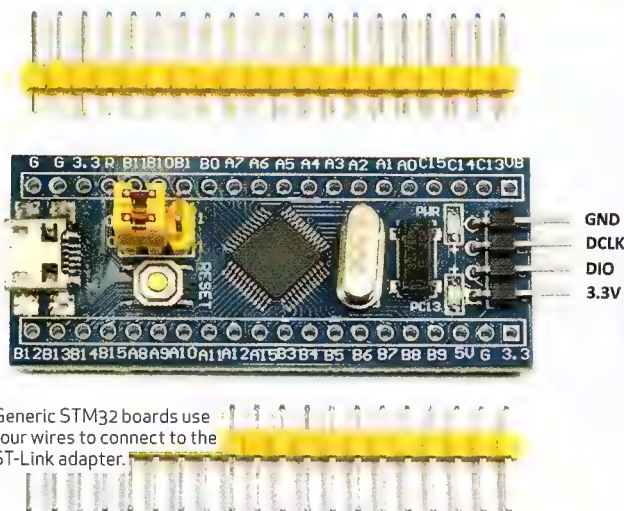
You can code the 'Blink' app to your STM32 board with the STLink adapter.



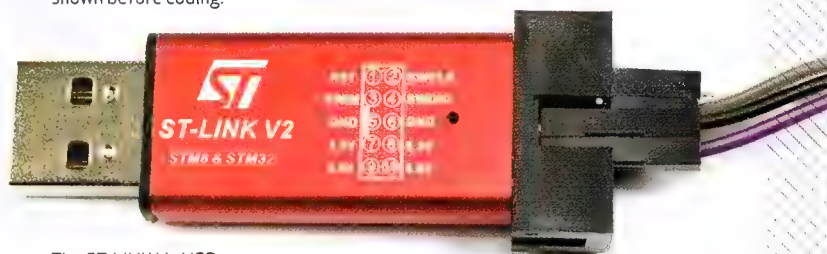
You need the STM32 Arduino hardware files from this GitHub page.



Set the Arduino IDE board settings to those shown before coding.



Generic STM32 boards use four wires to connect to the ST-Link adapter.



The ST-LINK V2 USB adapter hooks up your PC to the STM32 board.

understand – and for that, you need the ARM core libraries.

Launch the IDE and from the menu, select 'Tools > Board > Boards Manager' and look for the 'Arduino SAM Boards (32-bits ARM Cortex-M3)' entry. If not already installed, click on the Install button and download the libraries. Shut down the Arduino IDE when you're done. We also need the Arduino_STM32 hardware files created by Australian software engineer Roger Clark. You'll find these at GitHub via tinyurl.com/o6swzz3. Click on the green 'Clone or download' button, select the 'Download ZIP' link, grab the file, unzip it and copy the STM32_Arduino-Master folder to the /documents/Arduino/hardware folder on your PC (if the path doesn't exist, make it).

HOOKING UP THE ST-LINK ADAPTER

The ST-LINK adapter only requires four wires to connect to most STM32 boards – Vcc (3.3V), DCLK, DIO and GND. Vcc is the positive supply rail (it must be 3.3V), GND is ground or 0V, while DCLK is 'digital clock' and DIO is the digital input/output pin. Now look on the ST-LINK adapter itself, and on the front, you'll see a printed legend showing the pins numbered and their functions. The open notch in the rear bracket is your guide to pin orientation. You'll notice there are multiple GND and 3.3V pins – you can use any of these. But you will need Pin 2 (SWCLK) and Pin 4 (SWDIO).

When you buy the ST-LINK adapter, you should also receive a set of jumper wires – connect these appropriately.

A word of warning here: these STM32 boards come with a tiny microUSB port on the other end. Some will have four soldered anchor points, but others only two – you don't need it now, but be very careful when using this port. It doesn't take much to rip the two anchor-point connector right off the board.

HELLO WORLD

Now with the code libraries installed, the ST-LINK connected up to the STM32 board and plugged into a USB port, we're ready to code something. And by law, you must begin with the 'Hello World' of microcontroller projects – flashing the built-in test LED. Reboot your Arduino IDE and, from the menu, select 'File > Examples > 01. Basics' and 'Blink'. When the code loads, you'll see references to '13' in the pinMode and digitalWrite commands. You must change these to 'PC13', otherwise, it won't work.

But before you compile the code, you need to set the IDE's link with the STLink adapter. From the Arduino IDE menu, select 'Tools > Board' and if you have one of the boards we've shown, scroll down to 'STM32 boards (STM32duino.com)' and select 'Generic STM32F103C Series'. Set the 'Variant' option to 'STM32F103C8 (64K flash)' and the 'Upload method' to 'STLink'. When you're done, compile the code

(use the green tick icon at top-left just under the text menu). Don't worry about any warnings in the status area at the bottom, unless they cause the compile to fail. If you get the 'Done Compiling' message, you're good to go. At this point, the ST-LINK V2 USB adapter should have a pin-point blue LED lit. If you now compile and flash the code to the STM32 board using the green 'right-arrow' icon on the Arduino IDE, the blue LED should start flashing blue-red while the code is uploading to the board. As soon as it completes, you'll get 'MCU reset' and 'application started' in the status area. Your STM32 board's test LED should now start blinking on and off. Try changing the delay periods (they're in milliseconds) and see what effect it has. If you've got this far, congrats – you've just coded your first 32-bit microcontroller app.

POWERING THE STM32 BOARD

Once your code has been flashed to the board, you no longer need the ST-LINK adapter. Instead, you can now plug a cable into the microUSB port and power it from any suitable USB power source. You won't be able to code the board directly through the USB port, but it will provide power to run your project.

These STM32 boards aren't officially supported by the Arduino forums, so head to stm32arduino.com for more details. They can be a lower-cost way to start 32-bit development without the investment of an Arduino Zero or 101. ■

Learning Python #5: making a list

You can make lots of variables, but eventually, you need to get systematic about it. Darren Yates continues his Python series with a deep dive into lists.

So far in our Python series, every time we've created a variable for something, we've had to – to use an analogy – find a new 'bucket', give it a new name and then dump in whatever value we wanted stored. Do it often enough and not only does it get annoying, it can also become very confusing when you need lots of variables and have to keep thinking up new names – names like 'newVar23' aren't particularly useful.

That's where lists can work – not only do they make handling multiple related data values much easier, they can also perform all sorts of clever manipulation trickery. This month, we're heading off in search of all things 'lists'.

HOW LISTS WORK

Rather than having a new bucket for every variable you require, you can think of lists as customisable ice cube trays, where a variable actually contains multiple addressable or 'indexed' variables similar to the individual compartments of an ice cube tray. You can also add as many new 'tray cubes' as needed. In Python, you begin a list with a blank cube tray and fill cubes with values, as many as needed, each separated by a comma:

```
colours = ['red', 'green',
'blue', 'black', 'white']
```

Just as with a written list, each entity in that list is known as an 'item' and you can access items using their index, which indicates the position of each item in the list. A list's index range always starts from zero and goes up to one less than the total number of items. In the above case, 'colours[0]' gives us 'red', 'colours[3]' returns 'black'.

You can also alter the contents of a list by using the index. For example, to change 'blue' to 'grey', use the statement: `colours[2] = 'grey'`. This overwrites the 'colours' list at index 2 with the string 'grey'. If we now print 'colours[2]', we get 'grey'.

Lists can also store numbers – integer and floating-point. You just drop the quotation marks around each item, for example:



My Arduino-powered Enigma Cipher Machine.

```
batting_scores.py - D:\Lingtech Communications\2016\FUTURE\APC\436\mc-learn\code\SOURCE CODE\batting_scores.py (3.4.3)
File Edit Format Run Options Window Help
# APC Magazine - Issue 436 - Python Masterclass
# batting_scores.py
# Darren Yates 20 October 2016

batting_scores = [34, 39, 0, 99, 180, 15, 87, 23, 16, 2]
print('batting_scores (raw) :', batting_scores)

# calculate average manually
total_runs = 0
for score in batting_scores:
    total_runs += score
batting_average = total_runs / len(batting_scores)
print('Batting average:', batting_average)

# get highest and lowest scores
print('Highest score :', max(batting_scores))
print('Lowest score :', min(batting_scores))

# calculate median (middle) score manually
batting_scores.sort()
print('batting_scores (sorted):', batting_scores)
midIndex = int(len(batting_scores)/2)
if len(batting_scores)%2 != 0:
    median_score = batting_scores[midIndex]
else:
    median_score = (batting_scores[midIndex] + batting_scores[midIndex-1]) / 2
print('Median score (using manual coding) :', median_score)

# calculate average (mean) & median score using Python's statistics library
import statistics
print('Mean score (using statistics lib) :', statistics.mean(batting_scores))
print('Median score (using statistics lib):', statistics.median(batting_scores))
```

The multiple ways you can find the mean and median in a list of numbers.

```
batting_scores = [34, 39, 0,
99, 180, 15, 87, 23, 16, 2]
```

Using lists with numbers is really cool, as you now have all sorts of clever mathematical gymnastics functions at your disposal. The above is a list of cricket batting scores. Now the first thing you'd probably want to work out is the player's batting average. Mathematically, we do this by adding up

all of the scores and dividing the total by the number of scores. In Python, we can add up the scores in the list by using 'iteration', or looping through each item in the list. Here's one way to do it:

```
total_runs = 0
for score in batting_scores:
    total_runs += score
batting_average = total_runs / len(batting_scores)
```




If you think of variables as buckets, lists are like ice cube trays.

```
print('Batting average:',  
batting_average)
```

The second line of this code might seem a bit confusing at first, so here's what it does. The 'for' indicates the start of a for-loop, which we covered a couple of months ago. The 'score' initialises a new variable called 'score'. The 'in' operator indicates we want each value from the variable following (in this case, the 'batting_scores' list) to be stored in the 'score' variable. Another way to write this up in pseudo-code is 'for each score in the batting_scores list'.

We now run through or 'iterate' over the 'batting_scores' list, with each item in turn automatically placed into the

variable 'score' and added to the variable 'total_runs'. Once we've gone through the list, we then take the value in 'total_runs' and divide it by the length of the 'batting_scores' list. By 'length', we mean the number of items in the list. As we mentioned before, a list's index range extends from zero to one less than the total number of items, but the 'len()' function always returns the actual number of items, which in this case is 10. The value of 'total_runs' divided by the number of items is loaded into the variable 'batting_average', which we print using the print() statement. In this case, the player has a batting average of 49.5, which is excellent.

```
44  
# APC Magazine - Learn to code Python - Issue 436  
# EnigmaLite Encipher Machine  
# Darren Yates 19 October 2016  
  
rotor = [  
    ['E','K','M','F','L','G','D','Q','V','Z','N','T','O','W','Y','B','X','U','S','P','A','I','B','R','C','J'],  
    ['A','J','D','K','S','I','R','U','X','B','L','H','W','T','M','C','Q','G','Z','N','P','Y','F','V','O','E'],  
    ['B','D','F','H','J','L','C','P','R','T','X','V','Z','N','Y','E','I','W','G','A','K','M','U','S','Q','O'],  
]  
  
revRotor = [  
    ['U','W','Y','G','A','D','F','P','V','Z','B','E','C','K','M','T','H','X','S','L','R','I','N','Q','O','J'],  
    ['A','J','P','C','Z','W','R','L','F','B','D','K','O','T','X','U','Q','G','E','N','H','X','M','I','V','S'],  
    ['T','A','G','B','P','C','S','D','Q','E','U','F','W','N','Z','H','Y','I','X','J','W','L','R','K','O','M'],  
]  
  
reflectorB = [  
    ['A','B','C','D','E','F','G','H','I','J','K','L','M','N','O','P','Q','R','S','T','U','V','W','X','Y','Z'],  
    ['Y','R','U','H','Q','S','L','P','X','N','O','Z','I','W'],  
]  
  
def rotateRotors(r1start, r2start, r3start):  
    r1start += 1  
    r2start += 1  
    r3start += 1
```

The Enigma machine rotor settings can be stored as multi-dimensional lists.

```
Python 3.4.3 Shell  
Python 3.4.3 (v3.4.3:9b73f1c3e601, Feb 24 2015, 22:43:06) [MSC v.1600 32 bit (Intel)] on win32  
Type "copyright", "credits" or "license()" for more information.  
>>> ===== RESTART =====  
>>>  
  
----- APC Magazine EnigmaLite Cipher Machine -----  
Enter rotor start positions (eg. APC, <enter> to quit): APC  
Enter your message : MZABIM CU Y PTHQS XBPNLMMY HPXKQUCH QF EUPKI  
Your encoded message: PYTHON IS A GREAT COMPUTER LANGUAGE TO LEARN  
  
----- APC Magazine EnigmaLite Cipher Machine -----  
Enter rotor start positions (eg. APC, <enter> to quit): APC  
Enter your message : PWE  
Your encoded message: MAG  
  
----- APC Magazine EnigmaLite Cipher Machine -----  
Enter rotor start positions (eg. APC, <enter> to quit): MAG  
Enter your message : MNEOA WASHU ZDDQJ QNNTA TZWDF ADVHY  
Your encoded message: CRYPT OGRAP HYSEC UREST HEINT ERNET  
  
----- APC Magazine EnigmaLite Cipher Machine -----  
Enter rotor start positions (eg. APC, <enter> to quit): |
```

Using our 'Enigma Lite' cipher machine to encode-decode messages.

What you need

Here's what you'll need for this month's masterclass:
Python for Windows 3.5.x (free) - www.python.org/downloads
Masterclass source code - apcmag.com/magstuff.
Install Python, unzip the source code zip file, load a project '.py' source file, then run.

LIST FUNCTIONS

If you have a BASIC programming background, you might think lists sound similar to arrays. However, lists are far more versatile. Let's say in that 'batting_scores' list, we wanted to find out the batter's highest score. We can do that programmatically by using the max() function.

```
print('Highest score :',  
max(batting_scores))
```

We can also find the lowest score by using the min() function.

```
print('Lowest score :',  
min(batting_scores))
```

We can also remove scores, for example, removing all zero scores, using the remove() function. However, 'remove(0)' removes the first – and only first – zero score occurrence. If you know the index of a zero-score, the 'del batting_scores(index)' command also works, but you can't always guarantee knowing the index. One simple way of removing all zero scores is to use a try-except/while-loop combination like this:

```
try:  
    while(1):  
        batting_scores.  
remove(0)  
except ValueError:  
    print(batting_scores)
```

Using 'while(1)' is a common way of initialising a continuous loop, since '1' is always 'true', and while that loop runs, we keep removing the first zero-score found in the batting_scores list. The 'try-except' method provides our way out of the loop – as soon as there are no longer any zero scores, Python throws up a 'ValueError' error, which we catch with the 'except' clause. This now becomes the start point for any code following.

LIST COMPREHENSION

A more efficient but more complex method to remove all zero scores is to


```
Python 3.4.3 Shell
File Edit Shell Debug Options Window Help
Python 3.4.3 (v3.4.3:9b73f1c3e601, Feb 24 2015, 22:43:06) [MSC v.1600 32 bit (Intel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> ===== RESTART =====
>>>
batting_scores (raw) : [34, 39, 0, 99, 180, 15, 87, 23, 16, 2]
Batting average: 49.5
Highest score : 180
Lowest score : 0
batting_scores (sorted): [0, 2, 15, 16, 23, 34, 39, 87, 99, 180]
Median score (using manual coding) : 28.5
Mean score (using statistics lib) : 49.5
Median score (using statistics lib): 28.5
>>>
```

```
print(batting_scores)
midIndex = int(len(batting_scores)/2)
if len(batting_scores)%2 != 0:
    median_score = batting_scores[midIndex]
else:
    median_score = (batting_scores[midIndex] + batting_scores[midIndex-1]) / 2
print('Median score :', median_score)
```

After sorting the `batting_scores` list, we print the sorted list to the screen. Next, we find the middle index, which we do by dividing the length of the `batting_scores` list by two and using the `int()` function, storing the result in the variable `'midIndex'`. After that, we find out if the number of list items is odd or even – we can do this quickly using the modulus (%) operator. If dividing the length of the `batting_scores` list by two doesn't return a remainder of zero, it means we have an odd number of items and we just take the middle index. If we get an even result, we get the middle index plus the one before it and average the two, storing the result each time in `'median_score'`.

OKAY, NOW THE EASY WAY

So now that we can calculate the average (or 'mean') and median manually, here's how you can do it much more easily using Python's statistics library. You use the `'import'` statement and then call the `statistics.median()` and `statistics.mean()` functions, respectively.

```
import statistics
batting_scores = [34, 39, 0, 99, 180, 15, 87, 23, 16, 2]
print('Median score :', statistics.median(batting_scores))
print('Average score :', statistics.average(batting_scores))
```

What's important from this is that the batter's median is only 28.5, meaning half of the batter's scores are 28.5 or less, showing a possible weakness early on in an innings.

MULTI-DIMENSIONAL LISTS

So far, the lists we've been dealing with are one-dimensional – in mathematics, they're known as 'vectors'. But you can also expand lists into multi-dimensional entities called 'matrices'. In Python, you can think of them as 'lists of lists'. For example, we can create a list of pizzas and their ingredients:

```
pizzas = [
    ['Margherita', 'tomato base', 'oregano', 'cheese', 'garlic'],
    ['Italian Classic', 'tomato base', 'oregano', 'anchovies', 'kalamata olives'],
    ['Vegetarian', 'tomato base', 'onion', 'capsicum', 'mushroom', 'kalamata olives', 'pineapple', 'semidried tomatos']
]
```

```
pizzas.py - D:\Lingtech Communications\2016\FUTURE\APC\436\mc-learn\code\SOURCE CODE\pizzas.py (343)
# APC Magazine - Issue 436 - Python Masterclass
# pizzas.py
# Darren Yates 20 October 2016

pizzas = [
    ['Margherita', 'tomato base', 'oregano', 'cheese', 'garlic'],
    ['Italian Classic', 'tomato base', 'oregano', 'anchovies', 'kalamata olives'],
    ['Vegetarian', 'tomato base', 'onion', 'capsicum', 'mushroom', 'kalamata olives', 'pineapple', 'semidried tomatos']
]

print('Types of pizzas: ')
count = 0
for pizza in pizzas:
    count += 1
    print(count, ' * ', pizza[0])

pizzatype = int(input('Enter a number to list ingredients: '))-1
print('A', pizzas[pizzatype][0], 'pizza has the following ingredients: ')
for ingredients in range(1, len(pizzas[pizzatype])):
    print(' * ', pizzas[pizzatype][ingredients])
```

```
Python 3.4.3 Shell
File Edit Shell Debug Options Window Help
Python 3.4.3 (v3.4.3:9b73f1c3e601, Feb 24 2015, 22:43:06) [MSC v.1600 32 bit (Intel)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> ===== RESTART =====
>>>
Types of pizzas:
1 * Margherita
2 * Italian Classic
3 * Vegetarian
Enter a number to list ingredients: 3
A Vegetarian pizza has the following ingredients:
 * tomato base
 * onion
 * capsicum
 * mushroom
 * kalamata olives
 * pineapple
 * semidried tomatos
>>>
```

use 'list comprehension':

```
batting_scores = [score for score in batting_scores if score != 0]
```

Putting this another way with pseudo-code, the `batting_scores` list contains a score for each score in the `batting_scores` list if that score does not equal zero. List comprehension can be incredibly useful, but we won't pursue it further for now.

LIST MATHEMATICAL FUNCTIONS

The thing with averages is they don't always tell you the whole story of data – in fact, in this case, a batsman can get

one high score to cover over a multitude of poor scores and still end up with a decent batting average. Another option is to look at the median or middle score, which might tell us something else.

To do this programmatically, we need two steps – first, we sort the list into ascending order, then we grab the middle score. If we have an odd number of list items, we can take that middle score straight away, but if we have an even number of list items, we must average the two middle ones. Here's one way to do this:

```
batting_scores = [34, 39, 0, 99, 180, 15, 87, 23, 16, 2]
batting_scores.sort()
```




The genuine Enigma machine was electro-mechanical.



The key-activated rotors changed the encoding on each keystroke.

['Vegetarian', 'tomato bas
e', 'onion', 'capsicum', 'mushroom',
'kalamata
olives', 'pineapple', 'semidried
tomatos']

Each row list represents a different pizza, with the first element the pizza's name and the following elements in each row that pizza's ingredients. To access the 'Vegetarian' pizza, for example, we'd use `pizzas[2]` and to get the name of that pizza, `pizzas[2][0]`. Lists within multi-dimensional lists don't have to be the same length, so to identify the length of an internal list, you can use the `len()` function. For example, to find the length of the 'Italian Classic' pizza list, you'd use `len(pizzas[1])`. To list a pizza's ingredients, you can loop through from element [1] to element `[len(pizzas[row])]` using the range function like this:

```
for ingredients in range(1, len(pizzas[pizzatype])):
    print(' * ', pizzas[pizzatype][ingredients])
```

Here, 'pizzatype' is the list row number for the pizza you're interested in. You can see this work in more detail inside the 'pizzas.py' app in this month's source code pack.

MAKE AN ENIGMA MACHINE

Last month, we made a simple cipher tool for encoding messages using the trick of swapping characters based on ASCII codes – A becomes Z, B becomes Y

and so on. To finish off multi-dimensional lists this month, we've cranked things up a gear and created a simplified version of the Enigma Cipher Machine used by the German armed forces during World War II. We haven't implemented the full machine, but our version still uses the genuine wiring code from the first three rotors I, II and III (in that order), plus the 'B' reflector rotor used by the German army or 'Wehrmacht' machines. It also supports adjustable rotor start positioning. If you code a message with a genuine Enigma machine using rotors I, II, III with no rotor ring offset or plugboard, you can decode it with our 'EnigmaLite' Python code. Electrically, Enigma is little more than wires, switches and lightbulbs. But those electromechanical rotating rotor wheels that change position on each key press ensure pressing the same key any number of times will always get you a different encoded character each time.

HOW ENIGMALITE WORKS

To begin, you first type in the start positions of the three rotors, for example, 'APC'. Next, you type in your plain text message, press enter and you'll get the coded text. Reset the same rotor start positions, type in the coded text and you'll see the original plain text. Pressing the Enter key at the start quits the app. Have a go at cracking this message:

APC MZABIM CU Y PTHQS
XBPNLMMY HPXKQUCH QF EUPKI

The first three letters are the rotor start positions, the rest is the coded text. One trick the Germans used during the war to obfuscate message settings was to implement an encoded random message key. You start with three random letters, say 'APC' and choose a random message key, such as 'MAG'. Set the rotor positions to 'APC', encode 'MAG' and you get 'PWE'. You now set the rotor position to 'MAG' and encode the message. However, what you send is your initial 'APC' letters and the 'PWE' encoding, followed by the encoded message using the 'MAG' settings. At the other end, the operator sets the initial 'APC' settings, encodes 'PWE' to get back 'MAG' and then uses 'MAG' as the rotor start settings to decode the message. To further confuse hackers, operators broke a message into five-letter groups. Give this a go:

APC PWE MNEQA WASHU ZDDQJ
QNNTA TZWDF ADVHY

Enigma coding today will stop most uninterested people in their tracks, but it wouldn't take a cryptanalyst at the Australian Signals Directorate more than a cuppa to crack. By today's standards, Enigma is 'Cryptography 101' and although it has its flaws (exploited by British mathematician Alan Turing during the war to crack Enigma messages), it's still a fun exercise.

Lists are an important tool to have in your coding toolbox – they make sorting and performing mathematical functions much easier. We've barely scratched the surface of what they can do, but now we have them, we can bring out lists whenever we like!

downtime

» GAMES: EDITED BY TROY COLEMAN

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Battlefield 1

Doesn't turn the series on its head, but offers a refreshing change of pace.

I'm chasing a man carrying a pigeon. He dives into a building — a mistake, because I'm using an assault class loadout specced for short-range combat. I follow and get the drop on him. A couple of blasts from my Trench Shotgun take him down. He drops the pigeon. I pick it up, and start scribbling a note. The note — that is, the timer that dictates how long until the note is finished — writes faster when I'm standing still. I crouch in the building, and my teammates surround me. A gas grenade flies through the window. I tap 'T' to put on my gas mask, and continue to scribble.

Outside, I hear gunfire and shouting. When the note finishes, I sprint through the nearest door, round a corner and release the pigeon. The opposing team tries to shoot it, but it flies free. Moments later, an artillery strike rains down.

It's carnage. War Pigeons is a new mode for *Battlefield 1*. It's not the best, or the biggest, but it's a handy example of how DICE's latest multiplayer FPS handles its World War I setting. Just the concept of two armies running around fighting over a pigeon is inherently ridiculous. It's a mode that takes the seed of something historical — that pigeons were used to send messages in the war — and warps it to absurdity in order to create an enjoyable multiplayer mode.

And yet, it's also an effective showcase of some of *Battlefield 1*'s greatest strengths. It's still a multiplayer shooter about two teams, fighting over a series of objectives — attacking, defending or capturing, depending on the mode.

Soldiers charge over fields, tanks roam the streets and fighter planes dive and spiral overhead. On the micro level, squad leaders issue orders,

medics rush in to revive downed teammates, and snipers lay prone in what they hope is an unnoticed spot. Teams win or lose based on their ability to work together, to push on the objective, to fully utilise a broad spectrum of class roles. This is all stuff that, if you've played any *Battlefield* game, you have already seen and done hundreds of times before. The pace and style have both shifted, but only when judged within the constraints of what a *Battlefield* game is.

It's a better infantry game, too. The key to this is the early-20th century weapons and, paradoxically, how much worse they are. Guns here are less effective than their 21st century counterparts, and *Battlefield 1* is better for it.

Each weapon has its strength, but its weaknesses are more notable. A sniper's headshot is a guaranteed kill, but every rifle available

to the scout class is bolt action. If you miss, you waste precious seconds reloading the chamber while your target is running for cover.

SOUND BITES

Once again, DICE's sound design is extraordinary. The sense of power implied by each weapon's audio and animation makes most guns a pleasure to use. I predominantly play medic, and the selection of semi-automatic rifles feel gratifyingly hefty, even as I struggle against their kick.

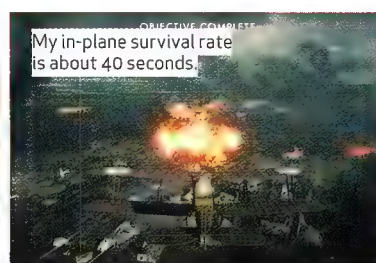
Audio has always been a big part of the series, and *Battlefield 1* is no different. Particular sound cues become crucial for processing the carnage of war, from the scream of a soldier in the middle of a bayonet charge, to the distinctive zip of a sniper's bullet narrowly missing your head. It enables you to parse important details invisibly, and makes the game feel better to play. The reworked weapons have a greater skill ceiling, and because of that,



Dogfighting is fun, but the skies are often quiet.



This seems an inefficient way to cook rations.



My in-plane survival rate is about 40 seconds.



Die a little quieter, Greg, I'm admiring this droplet effect.



Accurately, Battlefield 1's horses are worse than tanks.

your class choice and loadout feel more important. Each role has a stronger identity, and often excels at a different range. Even within those categories, it's possible to tailor for specific playstyles. The additional tools you carry feel more important, too. If you're playing medic, you'll likely stick with the tried and tested medibag and reviving syringe. But other classes have access to a broad range of kit.

Arguably, the biggest change is the way vehicles interact with the battlefield at large. Planes, tanks and horses are selected directly from the spawn menu, and vehicles feel less numerous than in previous games. Part of that is likely down to the absence of shoulder-mounted rocket launchers, making it harder for infantry to take down a tank. In addition, drivers can now repair tanks and planes (not horses) from inside the vehicle. The upshot is that a careful driver in a fully-manned heavy tank can be a significant problem, able to easily push forward a team's front line.

FOOT TRAFFIC

The maps feel smaller than

some of *Battlefield 4*'s biggest and most open environments — a possible casualty of how most traversal is done on foot. Despite this, map size still varies greatly, based on both mode and concept. Conquest maps tend to offer some of the biggest, but even here, you'll encounter outliers like Suez — a tight, linear map with only three capture points. In a 64-player match, things feel a little cramped.

The nine maps each offer a different set of challenges and considerations, whether it's the varied elevation of the mountainous Monte Grappa, the large, defensible mansion of Ballroom Blitz, or the wide open expanses of Sinai Desert.

Once again, Conquest and Rush are the main multiplayer draws, with Team Deathmatch, Domination and War Pigeons providing a secondary, infantry-only experience.

As usual, Team Deathmatch feels out of place, offering a simpler, objective-free match type in a game that really doesn't support that style. *Battlefield* is at its best when you're working towards objectives, collaborating with your squad to sneakily

back cap a point or arm a telegraph station.

Battlefield 1's multiplayer is undoubtedly the main draw, but in a rare move for the series, DICE has made an enjoyable, engaging singleplayer campaign. Called War Stories, it's an anthology collection, each mission following a different person at a different time and place in the war. The prologue switches between multiple protagonists, showing the impossible odds they face across the breadth of a single battle. Each War Story focuses on a different combat style, be it driving tanks, flying planes, or creeping around, quietly stabbing people in the chest. Each also uses a different framing device, letting DICE experiment with narrative styles. And yet, around that variation, the tone often oscillates between two extremes. At times, it's a respectfully sombre exploration of the harrowing tragedy of a senseless war. I enjoyed the singleplayer a lot — brief though it is.

War Stories fit well as a short, entertaining distraction away from the intense competition of multiplayer. Overall, the singleplayer lasts just 5–6

hours, but the structure feels well suited to expansion. If that is DICE's plan, I'd love for future episodes to cover other parts of the war — particularly from the French or even German perspective.

It is still, ultimately, just a *Battlefield* game. It offers many of the same experiences as its predecessors. Two things mitigate that.

Firstly, *Battlefield* is an excellent template for a multiplayer shooter. Few games provide the same sense of unpredictable sandbox drama, at least outside of more hardcore simulators such as *Arma 3*. Secondly, little differences can have a big impact. *Battlefield 1*'s little differences mean better infantry combat, a heightened sense of destruction, and a slower pace that feels more deliberate and tactical. This is no simple rehash and, while I appreciate *Battlefield 4*'s sense of scale, for me, *Battlefield 1* is the better of the two. ■ Phil Savage

Verdict

By returning to the past, *Battlefield 1* feels renewed. This is the best game in the series since *Bad Company 2*.



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Civilization VI

Discovering, decoding and developing a living world.

Civilization VI is the ultimate digital board game. More than ever in the series, the map is the soul of every opportunity and challenge. I'm playing for, with and against the board. Forests and deserts and resource-rich tundra influence the growth of my civilisation, granting it boons and burdening it with lasting weaknesses.

While Civ VI is probably the most transformative step forward for the series, its changes shouldn't trip up longtime players too much. You still settle cities, develop tiles, train military units, wage turn-based warfare and conduct diplomacy. It mirrored my memories of past Civs closely enough that hints from the in-game advisor were all I needed.

All the same, there are so many new features that it could feel overwhelming at times. It resembles a Civ game that's already had two or three expansions added

on top. What binds everything together is the map. I have reservations about the art style but the map itself, and its cities, iron mines and festival squares, is more alive than ever. I never needed to pull up an overlay to see which tiles were being worked, for example, because the models and animations did that job for me at a glance.

Spending a lot of time staring at hills, valleys and potential pyramid locations isn't just enjoyable and informative, however. It's critical to getting the most out of the game. Terrain and tile types have always been a factor but they're at the heart of nearly everything in Civ VI. With districts and wonders taking up a tile each, and being the most powerful tools I had to catapult myself toward victory, city planning became a huge focus.

There was never a time that I felt I could fill every tile with the most obviously

'correct' district or improvement and call it a day. The need for foresight is unending. There's a level of trial and error that caused me some frustration in my first few races to the space age. The map also ties into the tech and civics tree. Every technology and civic has an associated mini objective that will trigger a 'Eureka' moment and pay off half the cost immediately.

Founding a city next to an ocean tile sped up my progress toward sailing. Building three industrial districts with factories jumped me ahead in my quest to embrace communism. These advances are often tied to having room for specific districts, access to specific resources, or contact with other civilisations. It's not all reinvention. The Civ staples of war and diplomacy have returned, recognisable but honed to the sharpest edge. I particularly enjoyed the way AI leaders now have agendas (one public, and one

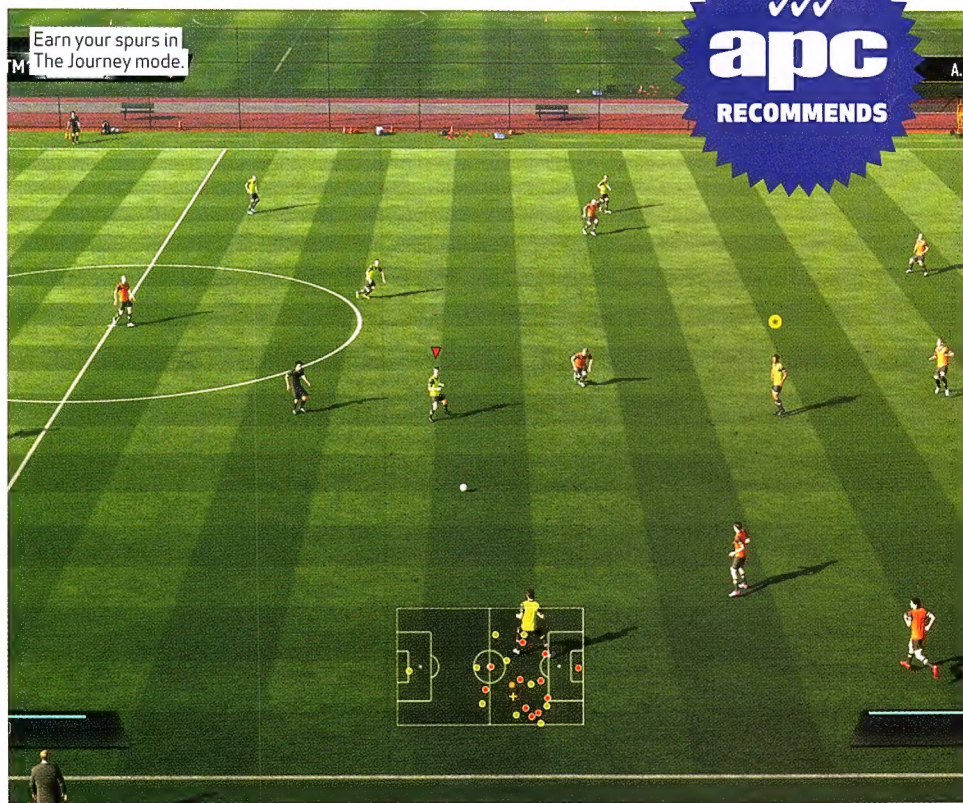
that must be uncovered) that make it theoretically possible to stay on everyone's good side if you're willing to jump through a lot of hoops.

When I looked down upon everything that I'd built as my Mars colonists blasted off to barely snatch victory from Peter and his moustachioed cronies, every tile struck me with a sense of history. For each valley, steppe and oasis, I could tell you why I'd developed it the way I did. As the board shaped my empire and I shaped it, the history of my civilisation and my decisions accumulated and followed me right up to the threshold of the stars. And that, more than anything, is why I'll never need another Civ game in my life besides this one. ■ TJ Hafer

Verdict

Sight, sound and systems harmonise to make this the liveliest, most engrossing and rewarding 4X on Earth.





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FIFA 17

Strolls to another easy win in the absence of a serious challenge from *Pro Evo*.

From George Best, through Gazza, to Adriano, every footballing generation has its own cautionary tale. These mercurial talents are so full of promise, capable of unbelievable skill and destined for even greater glories. Then, usually due to the temptations precipitated by fame, and possibly dispensed as a liquid, the player self destructs, ends up broke, sick or worse. But surely that won't befall EA's seemingly immortal *FIFA* series?

As expected, *FIFA 17* is bigger, more beautiful and generally better than *FIFA 16*. It's also better than *Pro Evo 2017* – or it certainly is on the PC. This year's game runs on the Frostbite Engine, which takes a little warming to.

There's also a new Active Intelligence System, which sounds like something that tracks aerial threats and

downs them with a surface-to-air missile. In practice, what it actually seems to do is sporadically prevent your teammates from making intelligent runs. Player collisions are the best I've seen in a football game – though the alchemy behind them is tricky to discern. The result is you're now rewarded for relentlessly battling for the ball or stretching a leg out to deflect a pass when closing down an opponent. 21 years on, it's reminiscent of *FIFA '96*, which felt like a dreadful grind but rewarded doggedness.

The early signs are that *FIFA 17* will have the same longevity, appeal as an online experience, and power to dominate your free time as *FIFA 16*. And when I say 'early', I mean 40 hours in. Because until I make it to division one of the attritional but glorious *FIFA* Ultimate Team mode, it's hard to say with complete certainty.

The big news for *FIFA* solo players is the inclusion of a story mode, which I was pretty sceptical about. But, to my surprise, *The Journey* is good. You guide plucky young phenom Alex Hunter from his under-11 cup final to the highs of a career in the Premier League. Through dialogue choices, you forge his personality, negotiating personal difficulties, footballing trials, loan spells and other career-defining moments. It's a very welcome additional way to play.

FIFA Ultimate Team (FUT) will remain everybody's mode of choice, though. Here, the act of converting kids' pocket money into a massive mountain of gold has been refined to an artform.

For *FIFA 17*, FUT has been tweaked with new competitions and the inclusion of a mode where you can trade combinations of unwanted players for rewards. Unsurprisingly, FUT's key new features seem designed to relieve you of

more cash, by offering incentives for you to buy obscure players for which there was otherwise little demand.

That said, *FIFA* is a wealthy but largely benign dictator. A particularly pleasing returning feature is a cumulative system that rewards your own fidelity to the series. Your level in the game carries over from previous versions, and with that comes free unlocks that dramatically reduce the grind. These include star player loans, attribute boosts and serious points multipliers to make acquiring the dosh you need to buy big much easier.

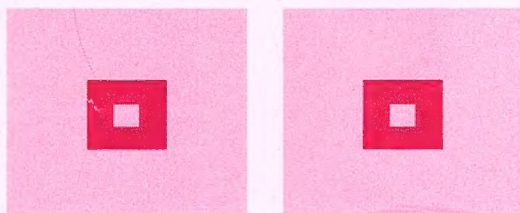
In the end, *FIFA* wins because it keeps on giving.

■ Lee Hall

Verdict

An epic ode to the joy of football, with some genuine advances, but there's room remaining for improvement.

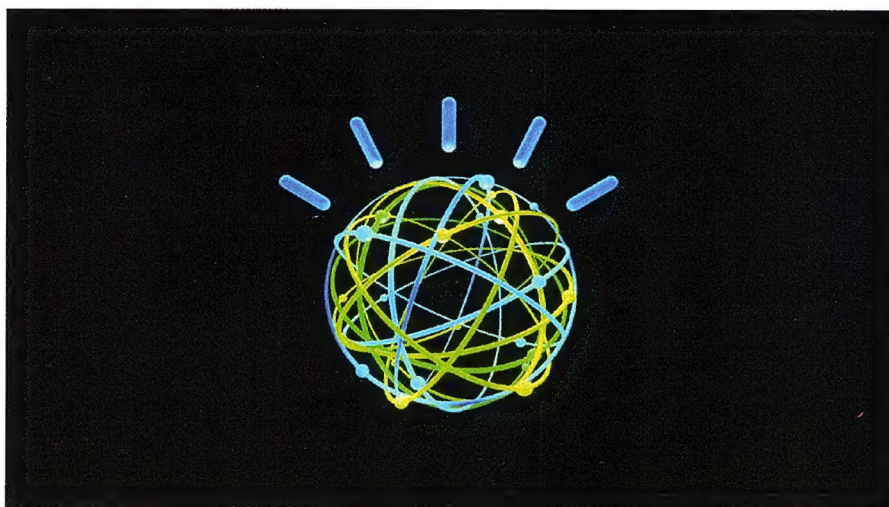




Facebook bans breast cancer awareness vid

But makers get creative with square boobs.

Promoting awareness of cancer is an important task. However, Facebook took down a 14-second Swedish Cancer Society video that showed animated (as in cartoon, not bouncing) female nipples as it reportedly marketed "sex products or services". A few days later, the society dished up a replacement ad that swapped out the round breasts for square ones. It then wrote an open letter to Facebook, saying (translated), "This cannot possibly offend you, or anyone." Facebook later apologised. This is not the first time the social media has faced a backlash for censorship regarding the naked body, as the famous 'Napalm Girl in Vietnam' image was also removed.



Elementary, my dear Watson

ADVERTISING IN YOUR CAR COULD SOON BECOME A REALITY.

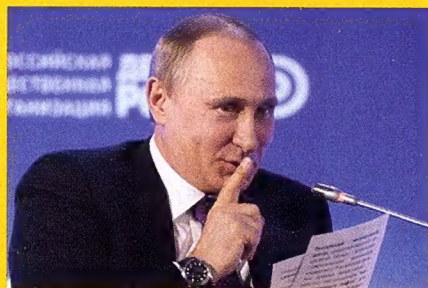
Your car is usually free of distractions like advertising. However, IBM's Watson AI — usually out helping scientists and engineers with complex problems, as well as competing on *Jeopardy!* and making movie trailers — could now lend its skills to General Motors. OnStar Go makes suggestions based on where you want to go, such as recommending an alternate route to work if traffic is dense, or suggesting you top up on fuel at the next station if you're looking to run out soonish. While these applications do seem convenient for drivers, the prospect of ads on the dashboard is enough to get the warning bells ringing.



Apple commands customer prove he is not a dead dictator

IN ORDER TO GET A REFUND.

Saddam Hussein was hanged on the 30th of December 2006 in Iraq. However, when Sharakat Hussain wished to return an iPhone 7 that he had bought for his sister, Apple sent him an email asking him to prove that he was not the dead Iraqi dictator before they could give him his refund. After initially assuming the email was spam, Sharakat was "stunned to learn it was real" and "furious to be linked to Saddam". Due to Sharakat's surname (which isn't even spelt the same, we'd like to note), he was placed on a Government Denied Parties list, and human error led to him being mistaken for Hussein. Apple has since apologised and is sorting out the refund for the iPhone.



Go out and meet someone in real life

RUSSIA BANS PORN WEBSITES.

PornHub and YouPorn are two of the biggest porn sites in the world, and both have recently been banned by Russia's media regulator, the Roskomnadzor. This has unsurprisingly caused many to voice their displeasure on social media, but the response from the Roskomnadzor was amusingly, "As an alternative, you could try and meet someone in real life." Due to the Russian Government's wont to censor the web — including shutting down sites criticising Vladimir Putin and those promoting LGBT news and rights — this action is hardly surprising. ■

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